

AIR FORCE



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HUMAN RESOURCES

**SHAPE DISCRIMINATION RESEARCH
USING AN IBM PC**

**Christopher D. Voltz
George A. Geri**

**University of Dayton Research Institute
300 College Park Avenue
Dayton, Ohio 45469**

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**OPERATIONS TRAINING DIVISION
Williams Air Force Base, Arizona 85240-6457**

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13. ABSTRACT (Maximum 200 words) A menu-driven program is described that is designed to control the presentation of visual stimuli and to collect and analyze response data in shape discrimination research. The program presents high resolution stimuli on an IBM PC equipped with an IBM Professional Graphics Adaptor (PGA) and an analog monitor. Bit-plane layering is employed to allow multiple test and adapting stimuli (1- to 2-bit gray scale) to be presented with specifiable interstimulus intervals. The program implements a double-random staircase paradigm, collects a subject's responses via the computer's parallel port, and analyzes the resulting data. In addition, auxiliary programs are provided for generating Fourier Descriptor shape stimuli, for modifying stimulus parameters, and for formatting and storing the final stimuli for use by the main program.				
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SUMMARY

A menu-driven program is described that is designed to generate and present visual stimuli for use in shape discrimination research. The main function of the program is to present stimuli on an IBM PC equipped with a Professional Graphics Adapter (PGA). The program is modular in design and may be easily modified for use with other laboratory computers. Provision has also been made for the presentation of several adapting and/or noise (masking) stimuli and for accurately controlling the temporal relationship of each to the primary stimuli. In addition, the program initializes the PGA, accepts subject specifications, and collects response data via a switch interfaced to the computer's parallel port. The response data are collected using a procedure that changes the test stimuli depending on the subject's previous response. Program options allow both analysis and plotting of the response data. Auxiliary programs are provided for generating stimulus outlines of various shapes; for modifying stimulus parameters such as spatial location, size, contour amplitude, and phase; and for formatting and storing the final stimuli such that they can be used by the main program.

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PREFACE

This research was performed in support of the Training Technology Planning Objective of the Research and Technology Plan at the Operations Training Division of the Air Force Human Resources Laboratory, Williams Air Force Base, Arizona. The general objective of this training research and development program is to identify and demonstrate cost-effective strategies and new training systems for developing and maintaining combat effectiveness. The purpose of the present experiment was to elucidate the basic mechanisms underlying visually guided behavior in flight simulators.

The authors thank Susan Baroff, who provided the auxiliary program for generating the Fourier Descriptor stimuli. Drs. Don Lyon, Yehoshua Zeevi, and John Uhlarik contributed to the design of the experimental procedures which have been implemented in the programs described in this report. We also thank Dr. Elizabeth Martin for her support and encouragement. This research was supported by the Air Force Office of Scientific Research, Work Unit 2313-T3-12, Cognitive Aspects of Flight Training, Dr. Elizabeth Martin, Principal Investigator; and by Air Force Contract F33615-87-C-0012 (UDRI), Flying Training Research Support, Capt. Paul M. Choudek, Contract Monitor.

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SHAPE DISCRIMINATION RESEARCH USING AN IBM PC

I. INTRODUCTION

The program FOURIER4.BAS, which is described here, has been used to conduct shape discrimination research in the Basic Research Laboratory at the Air Force Human Resources Laboratory, Williams AFB, Arizona. Shape stimuli, known as Fourier Descriptors (Kuhl & Giardina, 1982; Zahn & Roskies, 1972), were generated off-line and subsequently presented to observers who were asked to distinguish the various higher harmonic stimuli from a fundamental (elliptical) stimulus. The stimuli were presented in pairs whose members were displayed at various distances to the left and right of the fixation point-- thus constituting a two-alternative, spatial forced-choice paradigm. The amplitude associated with each harmonic stimulus was either reduced or increased on each trial depending on whether or not the observer was able to distinguish the two stimuli on the previous trial. The resulting data were analyzed using standard techniques and plotted when required.

As the program FOURIER4.BAS has been used as part of an ongoing visual shape discrimination research project, portions of the program and its documentation are specific to the stimuli and techniques used in that research. The program is, however, modular in design and we have indicated in the documentation some of the changes which may be made to adapt it to other experimental paradigms. For instance, stimuli other than Fourier descriptors may be used provided certain conventions are observed (e.g., the stimulus file must be in the PGA Run Length Encoded format [IBM, 1984], and the stimulus file names must be of the particular format used here). Also, changes can be made in the psychophysical procedures used to collect data as well as in stimulus characteristics such as color and intensity, the time interval between adapting and test stimuli, and the tradeoff between the number of stimuli and the number of gray-levels in each stimulus. Familiarity with the program's structure and function may be required in order to make some of the changes mentioned; and in some cases, readers may find it more expedient to use individual modules in their own programs.

II. DOCUMENTATION FOR PROGRAM "FOURIER4.BAS"

FOURIER4.BAS is a menu-controlled program whose primary function is to present visual stimuli on an IBM PC equipped with an IBM PGA. The program also (a) initializes the display controller, (b) randomizes trial blocks, (c) accepts subject specifications, (d) collects response data, (e) analyzes response data, (f) plots mean data, (g) demonstrates the chosen stimulus sequence, and (h) tests the subject response box. Note that the PGA requires an analog monitor (an IBM 8514 monitor, any NEC Multisync monitor, etc.). The program will present any images previously created using PGAGRAPH.BAS. (If single images are desired, a modification must be made in module BEGIN.TESTING wherever there are two consecutive calls to LOAD.SCREEN). The images to be used must reside in files named using the following convention: WWWXXYZ.IMG where "WWW" is the image specification (e.g., "P40" denotes a peripherally presented 40-mm stimulus), "XX" is the number of the harmonic (or other stimulus parameter), "Y" is the step level (0-9, and corresponding in the FD study to the harmonic amplitude), and "Z" is either 'L' or 'R' indicating whether the image is to be displayed to the left or to the right of the fixation point (assuming that image pairs are required). The field "WWW" may consist of any alphanumeric characters, whereas the fields "XX" and "Y" are numeric and padded as necessary with leading zeroes. Because FOURIER4.BAS, as presently configured, presents pairs of images, the images created using the program PGAGRAPH should, in general, not overlap (see description of the area-of-interest [AOI] box in the PGAGRAPH documentation). Further, if the fixation point is used, the images should not overlap the fixation point image.

The menu-option "ENTER STIMULUS INFO" is usually run once at the beginning of each experiment. This option prompts the user to enter the number of stimulus blocks (i.e., harmonics or other stimulus parameter), the particular harmonic levels to be run, and the starting amplitude (specified as a step from 0 to 9) of the upper and lower staircases. This information is stored in the file Fourier4.dat. The menu-options "INITIALIZE PGA," "RANDOMIZE TRIAL DATA," "ENTER SUBJECT DATA," and "COLLECT DATA" are run prior to each experimental session. For each of the stimulus blocks specified above, a double-random staircase sequence is implemented until the chosen number of response reversals (%max.num.trials) has occurred. In each trial, the subject is shown a pair of stimuli, one of which is a standard (here the first harmonic ellipse) that is presented randomly to the left or right of fixation. The second member of the pair is the stimulus associated with the block presently selected and the particular staircase step being run. The amplitude corresponding to each staircase step is determined by the specifications chosen when the images were created (using PGAGRAPH.BAS in the case of the FD stimuli). Following stimulus presentation, the subject responds by depressing a debounced switch corresponding to that side of the screen which appeared to contain the test stimulus. The switch is connected to parallel port #1 such that bits 7 and 3 (bits numbered left to right from 7 to 0) are toggled at each keypress. For the data analysis

and plotting output to be valid, it is necessary that the amplitude increment, chosen during image generation, matches the variable "amp.step" in section "GLOBAL VARIABLE INITIALIZATION." Note that data may be collected using unequal staircase step sizes, but in that case the data analysis cannot be done by this program.

To collect data, first initialize the display controller, randomize the stimulus blocks, and enter the subject information using the appropriate menu options. Next, select "DATA COLLECTION" and respond to all prompts (see also above). There are then two run options corresponding to whether or not an adapting stimulus is specified in menu-option "DATA COLLECTION."

If an adapting stimulus is specified, the following sequence is followed:

- (1) noise screen displayed until either switch is pressed,
- (2) stimulus in current block is previewed for subject,
- (3) noise screen displayed until next switch press,
- (4) adapting stimulus is displayed for 2 sec,
- (5) noise screen is displayed for 1 sec,
- (6) stimulus pair is displayed for 150 msec,
- (7) noise screen is displayed,
- (8) subject's response is recorded,
- (9) return to (1) if not end of block.

If no adapting stimulus is specified, the following sequence is followed:

- (1) display noise screen for 1 sec,
- (2) 1000 ms later, display the stimulus for 150 msec,
- (3) the noise screen is displayed,
- (4) the subject's response is recorded,
- (5) return to (1) if not end of block.

The module labeled BEGIN.TESTING is used to display the chosen stimuli and collect the experimental data. As it is the most complex of the modules, we provide the following description of its function.

The module does the following at the beginning of each experimental session (assuming that an adapting stimulus has been chosen):

- (A) opens the random number data file (Fourier4.dat),
- (B) reads the total number of blocks and the line number of the stimulus to be displayed next,
- (C) moves the pointer to that line (usually representing the first block unless this is a continuation of a previous session).

The module does the following [through (P)] for each of the stimulus blocks (whose number is specified by "num.block%"):

- (D) reads the upper and lower staircase starting points, reads the number of the stimulus to be displayed next (2, 4, 6, etc. in the case of the FD stimuli), and reseeds the random number generator.
- (E) initializes variables to be used for current block,

- (F) switches to the PGA display mode, displays blank screen, loads (but does not display) the chosen noise screen and displays the fixation point, loads the preview stimulus, and beeps,
- (G) waits for a signal from the response box,
- (H) displays the preview stimulus, displays a blank screen, waits for a signal from the response box, and displays the noise screen.

The module does the following [through (O)] until the maximum number of reversals (%max.num.trials) has occurred:

- (I) if the number of times a given staircase has been used (num.case%) is greater than the maximum (max.num.case%), then switches to the other staircase, or else picks a staircase at random;
- (J) determines the next amplitude to use for the current staircase and randomly chooses the side of the screen (side%=1 => left, side%=2 => right) on which to display the comparison (here zero-harmonic) stimulus;
- (K) loads in the test and comparison stimuli, presents the adapting stimuli if the adapting flag (adapt.flag%) is set, and then presents the noise screen, the test and comparison stimuli, and the noise screen again;
- (L) gets the subject's response, and writes to the output data file (opened by the "enter.subject.data" module) the current stimulus number, the current amplitude, which staircase (stair.case%=0 => upper, =1 => lower) was used, whether the response was correct (1) or incorrect (0), whether the subject responded left (0) or right (1), and the side on which the comparison stimulus was presented;
- (M) determines the amplitude to display when the current staircase is used next (as determined by the amplitude level [0-9] stored in "up.case%" and "low.case%"), sets the reversal flag (reversed%) if a reversal has occurred, and, if a reversal has occurred, increments the count of the number of reversals (num.trials%);
- (N) if the subject responded incorrectly, then sounds the error tone,
- (O) if the escape key has been pressed, then switches to the CGA display mode, closes the output file and returns to the main menu, otherwise returns to I);
- (P) prints a blank line to the output file, increments the block number, and returns to D);
- (Q) switches to the CGA display mode, prompts user for comments which are appended to the end of the output file, and closes the input and output files.

III. LISTING OF PROGRAM "FOURIER4.BAS"

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```

FILENAME: fourier4.bas
 CREATED: 6/08/87
 PROGRAMMER: Christopher Voltz - UDRI
 LAST MODIFIED: 5/17/89
 TARGET: IBM PC w/PGA
 LANGUAGE: Turbo BASIC v. 1.00

PROGRAM PURPOSE

This is a menu-controlled program whose primary function is to present pairs of stimuli on an IBM PC equipped with a Professional Graphics Adapter (PGA). See FOURIER.DOC for detailed documentation.

CONSTANT DEFINITIONS

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```

' *** system specific constants ***
 %buffer.size = 15000 'number of bytes to read in per disk access
 %escape.key = 27 'scan code returned by escape key

' *** menu display constants ***
 %entry.indent = 5 'number of spaces to indent data entry prompts
 %error.color = 28 'blinking light red
 %menu.color = 15 'bright white
 %menu.indent = 10 'number of spaces to indent menus
 %option.color = 3 'cyan

' *** response box constants ***
 %bit.mask = &810001000 'mask to clear extra bits
 %right.button = &810000000 'mask for second button
 %different.button = &810000000 'mask for first button
 %left.button = &800001000
 %same.button = &800001000
 %switch.port = &H379 'I/O address of switch port (LPT1:)

' *** boolean definitions ***
 %false = 0 'recognized by the compiler as false
 %true = -1 'recognized by the compiler as true

' *** staircase constants ***
 %num.noise = 5 'number of noise screens (1-9 max)
 %max.num.trials = 30 'number of reversals
 %max.amplitude = 9 'maximum possible amplitude
 %max.num.case = 2 'maximum number of repeats of a case
 %min.amplitude = 0 'minimum possible amplitude

' *** constants required to analyze data
 %ati = 5 'analyze table indentation (in spaces)
 %header.size = 12 'number of lines to read to skip header

```

55: %num.harmonics = 6 'number of harmonics in a file
56:
57:
58:
59:
60:
61:
62:
63: $INCLUDE "pga.inc" 'PGA communication routines
64: $INCLUDE "response.inc" 'response box routines
65: $INCLUDE "toolbox.inc" 'commonly used routines
66:
67:
68:
69:
70:
71:
72:
73:
74:
75: ' operational flags -- used for error checking primarily
76: adapt.flag% = %false 'assume adapting stimulus will not be used
77: data.flag% = %false 'subject data not loaded yet
78: demo.flag% = %false 'if in demonstration mode
79:
80: ' filename prefixes -- suffixes are assumed
81: adapt.file.names$ = "screens\" 'file name of adapting harmonic screen (.IMG)
82: data.file.names$ = "data\" 'file name of data output
83: fix.file.names$ = "screens\fixate.ing\" 'file name of fixation screen
84: image.file.names$ = "screens\" 'file name of screen images (.IMG)
85: noise.file.names$ = "screens\noise\" 'file name of noise screen (.SCR)
86: random.file.names$ = "fourier4.dat\" 'file name of random data
87: sample.images$ = "7\" 'file name prefix of sample harmonic
88: temp.file.names$ = "temp.dat\" 'file name of temporary data
89:
90: ' recognized keys
91: escape$ = CHR$(27) 'character string returned by escape key
92:
93: ' constants required to analyze data
94: amp.step! = 0.07 'amplitude step size
95:
96:
97:
98:
99:
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101:
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105:
106:
107:
108:
109:

```

```

110: DO CALL display.menu(response$)
111: LOOP UNTIL UCASE$(response$)="X"
112: END
113:
114:
115:
116: error_handler:
117: CALL PGA.transmit("CA DL 1 ")
118: IF (ERR<>55) AND (ERR<>255) THEN
119: CALL print.error("ERROR "+STR$(ERR)+" AT ADDRESS "+ STR$(ERADR)+".")
120: RESUME restart
121: ELSE
122: CLOSE
123: RESUME restart
124: END IF
125:
126:
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```

SUBROUTINES

ANALYZE.DATA

This module reads in a specified data file and analyzes it to produce the estimate of the mean and the standard deviation. Refer to "Introduction to Statistical Analysis" by Dixon and Massey, McGraw-Hill, 1957 for more information regarding staircase calculations.

```

SUB analyze.data
**** GLOBAL VARIABLE DECLARATIONS
  amp.step!
  data.file.name$
**** LOCAL VARIABLE DECLARATIONS
  LOCAL amp.amplitude%
  LOCAL done%
  LOCAL est.deviation!
  LOCAL est.mean!
  LOCAL file.name$
  LOCAL file.name$
  LOCAL file.name$
  LOCAL harmonic%
  LOCAL index%
  LOCAL index.2%
  LOCAL low.last%
  LOCAL num.files%

  amp.amplitude => %min.amplitude..%max.amplitude
  used to determine end of harmonic
  estimate of the standard deviation
  estimate of the mean
  filename of output file
  names of files to analyze
  whether data is only sent to file
  used to keep track of number of harmonics to be analyzed
  general loop variable
  general loop variable
  last response on lower staircase
  number of files to analyze

```

```

165: LOCAL print.scrn%
166: LOCAL response.1%
167: LOCAL response.2%
168: LOCAL reversed.low%
169: LOCAL reversed.up%
170: LOCAL staircase%
171: LOCAL sy2!
172: LOCAL temp$
173: LOCAL up.last%
174: LOCAL yn.total!
175: LOCAL yn2n.total!
176:
177:
178: LOCAL harmonics%()
179: LOCAL frequency%()
180: LOCAL n.total%()
181: LOCAL num.responses%()
182: LOCAL right%()
183: LOCAL table!()
184:
185: DIM harmonics%(xnum.harmonics)
186: DIM frequency%(xmax.amplitude, 1, xnum.harmonics)
187: DIM n.total%(1, xnum.harmonics)
188: DIM num.responses%(xnum.harmonics)
189: DIM right%(xnum.harmonics)
190: DIM table!(xmax.amplitude, 1, xnum.harmonics)
191:
192: CLS
193: COLOR xmenu.color
194: PRINT TAB(25);"FOURIER 4: ANALYZE DATA SCREEN"
195: PRINT
196: PRINT
197: COLOR %option.color
198:
199: PRINT TAB(xentry.indent); : INPUT "ENTER FILENAME OF OUTPUT FILE (.OTS) ";file.names$
200: PRINT TAB(xentry.indent); : INPUT "NAME OF FILE(S) TO ANALYZE (separated by one space) ";file.names$
201: file.names$ = file.names$ + " "
202: num.files% = 0
203: temp$ = file.names$
204: WHILE (temp$ <> "")
205:   INCR num.files%
206:   temp$ = MID$(temp$, INSTR(temp$, " ") + 1)
207: WEND
208:
209: file.only% = %TRUE
210: PRINT TAB(xentry.indent);"Display results on screen (Y/<N>) ";
211: CALL get.key(temp$)
212: IF UCASE$(temp$) = "Y" THEN file.only% = %FALSE
213:
214: print.scrn% = %FALSE
215: PRINT TAB(xentry.indent);"Print results on printer (Y/<N>) ";
216: CALL get.key(temp$)
217: IF UCASE$(temp$) = "Y" THEN print.scrn% = %TRUE
218:
219: OPEN data.file.names$ + file.names$ + ".OTS" FOR OUTPUT AS #2

```

```

220: PRINT #2, "FILENAME: ",data.file.names$ + file.names$ + ".OTS",,
221: PRINT #2, "CREATED: ",date$, " ",time$
222: PRINT #2, "FILE(S) BEING ANALYZED: ";
223: temp$ = file.names$
224: WHILE (temp$ <> "")
225:     PRINT #2, LEFT$(temp$, INSTR(temp$, " ") - 1) + ".DAT ";
226:     temp$ = MID$(temp$, INSTR(temp$, " ") + 1);
227: WEND
228: PRINT #2,
229: PRINT #2,
230: PRINT #2, " HARMONIC | .5-MEAN | SD/(n-.5) | MEAN | n | % Right"
231:
232: FOR index.2% = 1 TO num.files%
233:
234:     OPEN data.file.names$ + LEFT$(file.names$, INSTR(file.names$, " ") - 1) + ".DAT" FOR INPUT AS #1
235:     FOR index% = 1 TO %header.size
236:         INPUT #1, temp$
237:     NEXT
238:     INPUT #1, temp$
239:     done% = (temp$ = "")
240:     WHILE (NOT done%) AND (NOT EOF(1))
241:         low.last% = -1
242:         up.last% = -1
243:         reversed.low% = %FALSE
244:         reversed.up% = %FALSE
245:         WHILE (NOT done%) AND (NOT EOF(1))
246:             harmonic% = VAL(temp$)
247:             done% = -1
248:             FOR index% = 0 TO %num.harmonics
249:                 IF (harmonic% = harmonics%(index%)) THEN
250:                     done% = index%
251:                     END IF
252:             NEXT
253:             IF (done% = -1) THEN
254:                 FOR index% = %num.harmonics TO 0 STEP -1
255:                     IF (harmonics%(index%) = 0) THEN
256:                         done% = index%
257:                         END IF
258:                     NEXT
259:                     harmonics%(done%) = harmonic%
260:                     END IF
261:                     harmonic% = done%
262:                     temp$ = MID$(temp$, 3)
263:                     amplitude% = VAL(temp$)
264:                     temp$ = MID$(temp$, 3)
265:                     staircase% = VAL(temp$)
266:                     temp$ = MID$(temp$, 3)
267:                     index% = VAL(temp$)
268:                     temp$ = MID$(temp$, 3)
269:                     IF (staircase% = 0) THEN
270:                         IF (NOT reversed.up%) AND (index% <> up.last%) AND (up.last% <> -1) THEN
271:                             'set response code
272:                             'check for reversal
273:                             'set reversal flag
274:                             'save response for next time

```



```

275: ELSE IF (NOT reversed.low%) AND (index%<>low.last%) AND (low.last%<>-1) THEN
277:     reversed.low% = %TRUE
278:     END IF
279:     low.last% = index%
280:     'save response for next time
281:     IF (((staircase%=0) AND reversed.up%) OR ((staircase%=1) AND reversed.low%)) AND
282:     NOT ((index%=1) AND (amplitude%=0)), THEN
283:         INCR frequency%(amplitude%,index%,harmonic%)
284:         'increment count of response
285:         INCR num.responses%(harmonic%)
286:         'increment number of responses
287:         IF (VAL(temp$)=1) THEN
288:             INCR right%(harmonic%)
289:             'if subject pressed "right"
290:             INPUT #1, temp$
291:             done% = (temp$="")
292:             WEND
293:             INPUT #1, temp$
294:             done% = (temp$="")
295:             WEND
296:             IF (num.files%>1) THEN
297:                 file.names$ = MID$(file.names$, INSTR(file.names$, " ") + 1)
298:                 END IF
299:                 CLOSE #1
300:                 'next file
301:                 NEXT
302:                 'next file
303:                 NEXT
304:                 NEXT
305:                 '*** calculate Ni totals for each type of response at each harmonic
306:                 FOR index% = 0 TO 1
307:                     'OR amplitude% = 0 TO %max.amplitude
308:                     FOR harmonic% = 0 TO %num.harmonics
309:                         INCR n.total%(index%, harmonic%), frequency%(amplitude%, index%, harmonic%)
310:                     NEXT
311:                 NEXT
312:                 NEXT
313:                 NEXT
314:                 harmonic% = 0
315:                 WHILE (harmonics%(harmonic%)<>0) AND (harmonic%<=%num.harmonics)
316:                     IF (num.files%=1) THEN
317:                         COLOR %option.color
318:                         FOR index% = 0 TO 1
319:                             SCREEN ,,index%,index%
320:                             CLS
321:                             FOR index.2% = %max.amplitude TO 0 STEP -1
322:                                 PRINT TAB(%ati); USING "##.##" index.2%*amp.step!
323:                                 PRINT TAB(%ati);
324:                             NEXT
325:                             LOCATE CSRLIN-2, 1+%ati
326:                             PRINT TAB(%ati);
327:                             " L";
328:                             FOR index.2% = 1 to 33
329:

```

```

330: PRINT "L";
331: NEXT
332: PRINT
333: PRINT TAB(%ati); "Amplitude
334: Trial # =>";
335: NEXT
336:
337: OPEN data.file.name$ + LEFT$(file.names$, INSTR(file.names$, " ") - 1) + ".DAT" FOR INPUT AS #1
338: FOR index% = 1 TO %header.size
339: INPUT #1, temp$
340: NEXT
341:
342: **** skip thru file until correct harmonic is found
343: INPUT #1, temp$
344: index.2% = VAL(temp$)
345: WHILE (NOT EOF(1)) AND (index.2% <> harmonics%(harmonic%))
346: INPUT #1, temp$
347: index.2% = VAL(temp$)
348: WEND
349:
350: COLOR %menu.color
351: done% = (temp$ = "")
352: response.1% = 0
353: WHILE (NOT done%) AND (NOT EOF(1))
354: temp$ = MID$(temp$, 3)
355: amplitude% = VAL(temp$)
356: temp$ = MID$(temp$, 3)
357: staircase% = VAL(temp$)
358: temp$ = MID$(temp$, 3)
359: index% = VAL(temp$)
360: SCREEN , staircase%, staircase%
361: IF (staircase% = 0) THEN
362: INCR response.1%
363: LOCATE (%max.amplitude - amplitude%)*2 + 1, 5*ati + response.1%
364: ELSE
365: INCR response.2%
366: LOCATE (%max.amplitude - amplitude%)*2 + 1, 5*ati + response.2%
367: END IF
368: IF (index% = 1) THEN
369: PRINT "C";
370: ELSE
371: PRINT "I";
372: END IF
373: INPUT #1, temp$
374: done% = (temp$ = "")
375: WEND
376: CLOSE #1
377: END IF
378:
379:
380: **** determine which response to use
381: IF ((n.total%(0, harmonic%) < n.total%(1, harmonic%)) AND _
382: (n.total%(0, harmonic%) <> 0)) THEN
383: response.1% = 0
384: ELSE

```

```

385: response.1% = 1
387: END IF
388:
389:
390:
391:
392:
393:
394:
395:
396:
397:
398:
399:
400:
401:
402:
403:
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427:
428:
429:
430:
431:
432:
433:
434:
435:
436:
437:
438:
439:

```

```

      'use correct responses

      *** calculate (Yi * Ni) and (Yi^2 * Ni)
      FOR amplitude% = 0 TO %max.amplitude
        table!(amplitude%,0,harmonic%) = amplitude% * amp.step! * frequency%(amplitude%,response.1%,harmonic%)
        table!(amplitude%,1,harmonic%) = (amplitude%*amp.step!)^2 * frequency%(amplitude%,response.1%,harmonic%)
      NEXT

      *** calculate (Yi * Ni) and (Yi^2 * Ni) totals
      yn.total! = 0
      y2n.total! = 0
      'reset totals
      FOR amplitude% = 0 TO %max.amplitude
        INCR yn.total!, table!(amplitude%,0,harmonic%)
        INCR y2n.total!, table!(amplitude%,1,harmonic%)
      NEXT

      *** estimate mean and standard deviation and print results
      COLOR %menu.color
      SCREEN 0,0
      LOCATE (%max.amplitude*2+3), 1+%ati
      PRINT TAB(%ati); "FILENAME: ";file.names$, "UPPER STAIRCASE"
      PRINT TAB(%ati); "HARMONIC = ";harmonics$(harmonic%)
      IF (response.1% = 0) THEN
        est.mean! = yn.total! / n.total!(response.1%, harmonic%) + .5 * amp.step!
      ELSE
        est.mean! = yn.total! / n.total!(response.1%, harmonic%) - .5 * amp.step!
      END IF
      sy2l = (y2n.total! - yn.total!^2 / n.total!(response.1%, harmonic%)) / (n.total!(response.1%, harmonic%)-1)
      est.deviation! = 1.620*amp.step!*(sy2l/(amp.step!^2)+0.029)
      IF (n.total!(0, harmonic%) = 0) THEN
        PRINT TAB(%ati); USING " est.mean=###.### est.deviation=###.###"; -
        est.mean!; est.deviation!;
      ELSE
        PRINT TAB(%ati); USING " est.mean=###.### est.deviation=###.###"; -
        est.mean!; est.deviation!;
      END IF

      COLOR %menu.color
      SCREEN 1,1
      IF (num.files%>1) THEN CLS
      LOCATE (%max.amplitude*2+3), 1+%ati
      IF (num.files%=1) THEN
        PRINT TAB(%ati); "FILENAME: ";file.names$, "LOWER STAIRCASE"
      END IF
      PRINT TAB(%ati); "HARMONIC = ";harmonics$(harmonic%)
      IF (n.total!(0, harmonic%) = 0) THEN
        PRINT TAB(%ati); USING " est.mean=###.### est.deviation=###.###"; -
        est.mean!; est.deviation!;
      ELSE
        PRINT TAB(%ati); USING " est.mean=###.### est.deviation=###.###"; -
        est.mean!; est.deviation!;
      END IF
      PRINT #2, USING " ## | ##.### | ##.### | ##.### | ##.### "; -

```

```

440: harmonics%(harmonic%), 0.5-est,mean!, est,deviation!/SQR(n,total%(response.1%, harmonic%))
442: est,mean!, n,total%(response.1%, harmonic%), right%(harmonic%)/num.responses%(harmonic%)*100-
444:
445: IF (num.files%=1) THEN
446:   SCREEN ,0,0
447:   IF print.screen% THEN
448:     CALL INTERRUPT 5
449:     LPRINT : LPRINT : LPRINT
450:     DELAY 0.5
451:   END IF
452:   IF NOT file.only% THEN
453:     COLOR %error.color
454:     LOCATE 25,1+%ati
455:     PRINT "PRESS ANY KEY TO CONTINUE";
456:     CALL get.key(temp%)
457:   END IF
458:   SCREEN ,1,1
459:   IF print.screen% THEN
460:     CALL INTERRUPT 5
461:     LPRINT CHR$(12);
462:     DELAY 4
463:   END IF
464:   IF NOT file.only% THEN
465:     COLOR %error.color
466:     LOCATE 25,1+%ati
467:     PRINT "PRESS ANY KEY TO CONTINUE";
468:     CALL get.key(temp%)
469:   END IF
470:   INCR harmonic%
471: WEND
472:
473: CLOSE #2
474:
475: END SUB
476:
477:
478:
479:
480:
481:
482:
483:
484:
485:
486:
487:
488:
489:
490:
491: SUB begin.testing
492:
493:   ' **** VARIABLE DECLARATIONS
494:   LOCAL amplitude%
         'current amplitude

```

BEGIN TESTING

This module is used to display the chosen stimuli and collect the experimental data. See FOURIER4.DOC for more detailed information.

```

495: LOCAL block%
496: LOCAL file.names$
497: LOCAL harmonic%
498: LOCAL last.case%
499: LOCAL low.case%
500: LOCAL low.response%
501: LOCAL num.of.harmonic%
502: LOCAL num.case%
503: LOCAL num.trials%
504: LOCAL response%
505: LOCAL reversed%
506: LOCAL side%
507: LOCAL stair.case%
508: LOCAL temp$
509: LOCAL up.case%
510: LOCAL up.response%
511:
512:
513:
514:
515:
516:
517:
518:
519:
520:
521:
522:
523:
524:
525:
526:
527:
528:
529:
530:
531:
532:
533:
534:
535:
536:
537:
538:
539:
540:
541:
542:
543:
544:
545:
546:
547:
548:
549:

'number of harmonics displayed in session
'filename of screen to be loaded
'harmonic number in use
'last staircase used (D=upper, -1=lower)
'amplitude to use next for lower staircase
'last response for lower staircase
'number of lines in data file
'number of times either case has been repeated
'number of reversals
'subject's response
'whether a reversal has occurred or not
'side of screen nonfundamental is put on
'current staircase
'temporary string variable
'amplitude to use next for upper staircase
'last response for upper staircase

' **** GLOBAL DECLARATIONS
SHARED demo.flag%
SHARED escape$
SHARED image.file.names$
SHARED image.size$
SHARED random.file.names$
SHARED sample.image$
SHARED temp.file.names$

'character string returned by escape key
'file name of screen images (.SCR)
'size of images in mm
'file name of random harmonic data
'file name prefix of sample harmonic
'file name of temporary data

CLS
COLOR %menu.color
PRINT TAB(24);"FOURIER 4: DATA COLLECTION SCREEN"

OPEN random.file.names$ FOR INPUT AS #3
INPUT #3, num.blocks%, number.of.harmonic%
FOR block% = 2 TO number.of.harmonic%
  INPUT #3, harmonic%, up.case%, low.case%
NEXT
block% = 1
WHILE (block% <= num.blocks%) AND (NOT EOF(3))
  INPUT #3, harmonic%, up.case%, low.case%
  RANDOMIZE TIMER
  up.response% = -1 'set last response, to upper case, to illegal value
  low.response% = -1 'set last response, to lower case, to illegal value
  last.case% = -2 'set last used to illegal value
  num.case% = 0 'reset number of repeats of case
  num.trials% = 0 'reset number of reversals
  reversed% = %FALSE 'no reversal has occurred yet
  '**** display blank screen, sample harmonic, blank screen
  CALL PGA.transmit("01,01,2,2,51,2,2,2,51,3,2,2,51,4,2,2,5 ")
  CALL PGA.transmit("1,5,2,2,51,6,2,2,51,7,2,2,51,8,2,2,5 ") 'blank screen
  CALL load.noise.screen

```

```

550: temp$ = STR$(harmonic%)
551: IF (harmonic% < 10) THEN
552:   temp$ = "0" + RIGHT$(temp$, LEN(temp$)-1)
553: ELSE
554:   temp$ = RIGHT$(temp$, LEN(temp$)-1)
555: END IF
556: file.name$ = image.file.name$ + image.size$ + temp$ + sample.image$ + ".L.IMG"
557: CALL PGA.transmit("WK,2 ")
558: CALL load.screen(file.name$)
559: file.name$ = image.file.name$ + image.size$ + temp$ + "OR.IMG"
560: CALL load.screen(file.name$)
561: BEEP
562: CALL get.response(response%) 'wait for subject to press a key
563: CALL PGA.transmit("L,2,5,6,11 L,3,5,6,11 L,6,5,6,11 L,7,5,6,11 L,8,5,6,11 W,120 ")
564: IF demo.flag% THEN
565:   CALL get.response(response%)
566:   CALL get.response(response%)
567: END IF
568: CALL PGA.transmit("L,2,2,2,5 L,3,2,2,5 L,6,2,2,5 L,7,2,2,5 L,8,2,2,5 ")
569: CALL get.response(response%) 'wait for response
570: CALL PGA.transmit("L,1,6,6,12 L,3,6,6,12 L,5,6,6,12 L,7,6,6,12 L,8,6,6,12 ")
571: WHILE (num.trials% < %max.num.trials)
572:   IF (num.case% = %max.num.case) THEN
573:     stair.case% = NOT last.case%
574:     num.case% = 0
575:   ELSE
576:     stair.case% = INT(RND*2)-1
577:     IF (stair.case% = last.case%) THEN
578:       INCR num.case%
579:     ELSE
580:       num.case% = 0
581:     END IF
582:   END IF
583:   IF (stair.case%=0) THEN
584:     amplitude% = up.case%
585:   ELSE
586:     amplitude% = low.case%
587:   END IF
588:   side% = INT(RND*2)
589:   temp$ = STR$(harmonic%)
590:   IF (harmonic% < 10) THEN
591:     temp$ = "0" + RIGHT$(temp$, LEN(temp$)-1)
592:   ELSE
593:     temp$ = RIGHT$(temp$, LEN(temp$)-1)
594:   END IF
595:   file.name$ = image.file.name$ + image.size$ + temp$
596:   CALL PGA.transmit("WK,2 ")
597:   IF (side%=0) THEN
598:     file.name$ = file.name$ + CHR$(amplitude% + ASC("0")) + ".L.IMG"
599:     CALL load.screen(file.name$) 'load image on left side
600:     file.name$ = LEFT$(file.name$,2+LEN(image.file.name$)+LEN(image.size$)) + "OR.IMG"
601:     CALL load.screen(file.name$) 'load fundamental on right side
602:   ELSE
603:     file.name$ = file.name$ + CHR$(amplitude% + ASC("0")) + ".R.IMG"
604:

```

```

605: CALL load.screen(file.name$) 'load image on right side
607: file.name$ = LEFT$(file.name$, 2*LEN(image.file.name$)+LEN(image.size$)) + "0L.JPG"
608: CALL load.screen(file.name$) 'load fundamental on left side
609: END IF
610: IF demo.flag% THEN
611: CALL demo.screens
612: ELSE
613: CALL flash.screens
614: END IF
615: CALL get.response(response%)
616: PRINT #1, USING "##":harmonic%;
617: PRINT #1, USING "#":amplitude%;
618: IF (stair.case% = 0) THEN
619: PRINT #1, "0 ";
620: ELSE
621: PRINT #1, "1 ";
622: END IF
623: IF (amplitude% <> 0) AND
624: ((response% = %left.button) AND (side% = 0)) OR
625: ((response% = %right.button) AND (side% = 1)) THEN
626: PRINT #1, "1 ";
627: ELSE
628: PRINT #1, "0 ";
629: END IF
630: IF (response% = %left.button) THEN
631: PRINT #1, "0";
632: ELSE
633: PRINT #1, "1";
634: END IF
635: PRINT #1, side%
636: IF (stair.case% = 0) THEN
637: IF ((response% = %left.button) AND (side% = 1)) OR
638: ((response% = %right.button) AND (side% = 0)) OR
639: (amplitude% = 0) THEN
640: IF (up.case% < %max.amplitude) THEN INCR up.case%
641: reversed% = (up.response% = 0)
642: up.response% = 1
643: ELSE
644: IF (up.case% > %min.amplitude) THEN DECR up.case%
645: reversed% = (up.response% = 1)
646: up.response% = 0
647: END IF
648: ELSE
649: IF ((response% = %left.button) AND (side% = 1)) OR
650: ((response% = %right.button) AND (side% = 0)) OR
651: (amplitude% = 0) THEN
652: IF (low.case% < %max.amplitude) THEN INCR low.case%
653: reversed% = (low.response% = 0)
654: low.response% = 1
655: ELSE
656: IF (low.case% > %min.amplitude) THEN DECR low.case%
657: reversed% = (low.response% = 1)
658: low.response% = 0
659: END IF

```

```

660: END IF
661: last.case% = stair.case%
662: IF reversed% THEN INCR num.trials%
663: IF (((response% = %left.button) AND (side% = 1)) OR
664: ((response% = %right.button) AND (side% = 0))) AND
665: (amplitude% <> 0) THEN
666: PLAY "LT0N1"
667: END IF
668: IF INKEY$=escape$ THEN
669: CALL pga.transmit("CA DI,1 ")
670: PRINT #1,
671: PRINT #1, "COMMENTS: "
672: PRINT #1, " Terminated early by user."
673: CLOSE #1
674: CLOSE #3
675: EXIT SUB
676: END IF
677: WEND
678: PRINT #1, 'trial
679: block% = block% + 1
680: block% = block%
681: WEND
682: CALL pga.transmit("CA DI,1 ")
683: PRINT
684: PRINT
685: PRINT TAB(%entry.indent);
686: COLOR %option.color
687: INPUT "ENTER COMMENTS: ";temp$
688: PRINT #1, "COMMENTS: "
689: PRINT #1, " ";temp$
690: PRINT #1, "close data file
691: CLOSE #1
692: CLOSE #3
693: CLOSE #3
694: END SUB
695:
696:
697:
698:
699:
700:
701:
702:
703:
704:
705:
706:
707:
708:
709:
710:
711:
712:
713:
714:

```

DEMO.SCREENS

This module displays the adapting screen if necessary, then displays the noise screen, then the stimulus screen, and returns to the noise screen and the calling module. A beep is sounded in between the adapting screen and noise screen. (If the adapting screen is not to be shown, the beep is sounded immediately.) The adapting screen is shown for 1000 ms. The noise is displayed for 1000 ms if the adapting screen has been displayed or for 1000 ms if the adapting screen has not been displayed. The stimulus is displayed for 150 ms. NOTE: in between each screen display, the module waits for the user to press a response key.


```

715: '
717: SUB demo.screens
719: ' **** LOCAL DECLARATIONS
720: LOCAL response%
721:
722: ' **** GLOBAL DECLARATIONS
723: SHARED adapt.flag%
724: SHARED demo.flag%
725:
726:
727:
728: IF adapt.flag% THEN
729: CALL get.response(response%)
730: 'show adapting harmonic
731: CALL PGA.transmit("L,1,2,2,5 L,3,2,2,5 L,4,5,6,11 L,5,5,6,11 L,6,5,6,11 L,7,5,6,11 W,120 ")
732: CALL get.response(response%)
733: 'show noise screen
734: CALL PGA.transmit("L,1,6,6,12 L,3,6,6,12 L,4,2,2,5 L,5,6,6,12 L,6,2,2,5 L,7,6,6,12 W,60 ")
735: CALL get.response(response%)
736: ELSE
737: 'show noise screen
738: CALL PGA.transmit("W,60 ")
739: CALL get.response(response%)
740: END IF
741:
742: 'show stimulus
743: CALL PGA.transmit("L,1,2,2,5 L,2,5,6,11 L,3,5,6,11 L,5,2,2,5 L,6,5,6,11 L,7,5,6,11 L,8,5,6,11 W,9 ")
744: CALL get.response(response%)
745:
746: 'show noise
747: CALL PGA.transmit("L,1,6,6,12 L,2,2,2,5 L,3,6,6,12 L,5,6,6,12 L,6,2,2,5 L,7,6,6,12 ")
748:
749: END SUB 'demo.screens
750:
751:
752:
753:
754:
755:
756:
757:
758:
759:
760:
761:
762:
763:
764:
765:
766:
767:
768:
769:

```

DISPLAY.MENU

This module displays the menu options, gets a keystroke, and executes the appropriate module. The keystroke is returned to the main program.

```

SUB display.menu(response%)
SHARED demo.flag%
SHARED escape$
'**** setup the screen

```

```

770: CLS
771: COLOR %menu.color
772: PRINT TAB(31); "FOURIER 4: MAIN MENU"
773: PRINT
774: PRINT
775: PRINT
776: PRINT
777: CALL print.option("I|INITIALIZE PGA")
778: CALL print.option("R|RANDOMIZE TRIAL DATA")
779: CALL print.option("E|ENTER SUBJECT DATA")
780: CALL print.option("D|DEMO")
781: CALL print.option("C|COLLECT DATA")
782: CALL print.option("A|ANALYZE DATA")
783: CALL print.option("P|PLOT SUM FILE")
784: CALL print.option("S|ENTER STIMULUS INFO");
785: CALL print.option("T|TEST RESPONSE BOX")
786: CALL print.option("X|EXIT PROGRAM")
787: CALL print.option("<ESC>|<ESC> TERMINATE PROGRAM")
788: PRINT
789: PRINT
790: PRINT TAB(%entry.indent); "ENTER OPTION: ";
791:
792:
793:
794: CALL get.key(response$)
795: PRINT response$;
796:
797:
798:
799:
800:
801:
802:
803:
804:
805:
806:
807:
808:
809:
810:
811:
812:
813:
814:
815:
816:
817:
818:
819:
820:
821:
822:
823:
824:

```

```

      *** get the user's option
      echo keypress

      *** execute option
      SELECT CASE UCASE$(response$)
      CASE "A"
        CALL analyze.data
      CASE "C"
        IF NOT data.flag% THEN
          CALL print.error("ERROR: subject data not loaded yet.")
        ELSE
          demo.flag% = %false
          CALL begin.testing
          data.flag% = %false
        END IF
      CASE "D"
        IF NOT data.flag% THEN
          CALL print.error("ERROR: subject data not loaded yet.")
        ELSE
          demo.flag% = %true
          CALL begin.testing
          data.flag% = %false
        END IF
      CASE "E"
        CALL enter.subject.data
        data.flag% = %true
      CASE "I"
        CALL initialize.pga
        noise.flag% = %false
      CASE "P"
        CALL plot.sum.file
      CASE "R"
        randomize the trial data

```

```

825: CALL randomize.trial.data
827: CASE "SI"
828: CALL confirm(response$)
829: IF UCASE$(response$) = "Y" THEN
830: CALL make.random.info
831: END IF
832: CASE "TI"
833: CALL test.response.box
834: CASE "XI", escape$
835: CALL exit.program
836: response$ = "X"
837: CASE ELSE
838: BEEP
839: END SELECT
840:
841: END SUB
842:
843:
844:
845:
846:
847:
848:
849:

```

ENTER.SUBJECT.DATA

This module reads the subject's data, opens the output file ("XXX\YYYYZZZZ.DAT" where XXX is the data directory, YYYY is the subject's initials and ZZZZ is the session number) and saves the data to it (with the current date). The file is left open. The user is asked to confirm that he has correctly entered the data. If he presses any key other than Y, the file will be closed and erased and the user will be asked for the subject's data again. This module also loads in the adapting stimulus screen if the number entered for the adapting harmonic is not zero.

```

850:
851:
852:
853:
854:
855:
856:
857:
858:
859:
860:
861:
862:
863: SUB enter.subject.data
864:
865: ' **** VARIABLE DECLARATIONS
866: LOCAL good% 'boolean used to determine if data was entered correctly
867: LOCAL file.name$ 'filename of data output file
868: LOCAL string.1$ 'general string variable
869: LOCAL string.2$ 'general string variable
870:
871: ' *** GLOBAL VARIABLE DECLARATIONS
872: SHARED adapt.flag% 'adapting stimulus operation flag
873: SHARED adapt.file.name$ 'prefix of adapting stimulus files
874: SHARED data.file.name$ 'prefix of data files
875: SHARED fix.file.name$ 'fixation point file name
876: SHARED image.file.name$ 'prefix of image files
877: SHARED image.size$ 'size of image in mm
878:
879: DO

```

```

880: good% = %false      'assume entries are incorrect
882:
883:      '*** setup screen
884:
885:      CLS
886:      COLOR %menu.color
887:      PRINT TAB(23); "FOURIER 4: SUBJECT DATA ENTRY SCREEN"
888:      PRINT
889:      COLOR %option.color
890:
891:      '*** get data to create filename
892:      PRINT TAB(%entry.indent); : INPUT "SUBJECT INITIALS: ", string.1$
893:      PRINT TAB(%entry.indent); : INPUT "SESSION NUMBER: ", string.2$
894:
895:      '*** determine filename and open data file
896:      file.names$ = data.file.names$ + string.1$ + string.2$ + ".DAT"
897:      OPEN file.names$ FOR OUTPUT AS #1
898:
899:      '*** save header in data file and print data
900:      PRINT #1, "FOURIER 4 Data file: "; file.names$, "Created: "; date$
901:
902:      PRINT #1, "SUBJECT INITIALS: "; string.1$
903:      PRINT #1, "SESSION NUMBER: "; string.2$
904:
905:      '*** get rest of data and save it
906:      PRINT TAB(%entry.indent); : INPUT "STANDARD: ", string.1$
907:      PRINT #1, "STANDARD: "; string.1$
908:
909:      '*** get adapting harmonic and load screens if necessary
910:      PRINT TAB(%entry.indent); : INPUT "ADAPTING HARMONIC: ", string.1$
911:      PRINT #1, "ADAPTING HARMONIC: "; string.1$
912:      IF string.1$ <> "0" THEN
913:          CALL PGA.transmit("MK,4 ")
914:          CALL load.screen(adapt.file.names$+string.1$+"L.IMG")
915:          CALL load.screen(adapt.file.names$+string.1$+"R.IMG")
916:          CALL PGA.transmit("MK 8 ")
917:          CALL load.screen(fix.file.names$
918:              adapt.flag% = %true
919:          )
920:      END IF
921:
922:      COLOR %option.color
923:      PRINT TAB(%entry.indent);
924:      INPUT "ENTER TEST STIMULUS SIZE (1st 3 chars of image set): ", image.size$
925:      PRINT #1, "TEST STIMULUS SIZE: "; image.size$
926:
927:      PRINT #1, " HARMONIC # | AMPLITUDE # | STAIRCASE | CORRECT | RESPONSE | SIDE"
928:      PRINT #1, "2 4 6 8 12 16 | 0-8 | 0=upper 1=lower | 0=wrong 1=correct | 0=left 1=right"
929:      PRINT #1,
930:
931:      '*** make sure everything is OK
932:      CALL confirm(string.1$)
933:      IF UCASE$(string.1$) = "Y" THEN
934:          'everything OK?

```

```

935:         good% = %true
937:     ELSE
938:         CLOSE #1
939:         KILL file.name$
940:     END IF
941:
942:     LOOP UNTIL good%
943: END SUB
944:
945:
946:
947:
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987:
988:
989:

```

```

' yes.
'no, so:
'close the file
'and erase it

```

```

'repeat until everything is OK

```

EXIT.PROGRAM

This module is called at program termination. It resets the screen back to CCA emulation mode, closes all files, and prints a termination message.

```

SUB exit.program

```

```

CLS
CALL PGA.transmit("CA DI,1 ")
CLOSE
PRINT "PROGRAM TERMINATED."

```

```

END SUB

```

FLASH.SCREENS

This module displays the adapting screen if necessary, then displays the noise screen, then the stimulus screen, and returns to the noise screen and the calling module. A beep is sounded in between the adapting screen and noise screen. (If the adapting screen is not to be shown, the beep is sounded immediately.) The duration of the adapting, noise, and stimulus screens is determined by the number (#) of screen refreshes specified by "W,#".

```

SUB flash.screens

```

```

' **** GLOBAL DECLARATIONS
SHARED adapt.flag%

```

```

990:
991: IF adapt.flag% THEN
992: 'show adapting harmonic
993: CALL PGA.transmit("L,1,2,2,5 L,3,2,2,5 L,4,5,6,11 L,5,5,6,11 L,6,5,6,11 W,120 ")
994: 'show noise screen
995: CALL PGA.transmit("L,1,6,6,12 L,3,6,6,12 L,4,2,2,5 L,6,2,2,5 W,60 ")
996: ELSE
997: 'show noise screen
998: CALL PGA.transmit("W,60 ")
999: END IF
1000:
1001: 'show stimulus
1002: CALL PGA.transmit("L,1,2,2,5 L,2,5,6,11 L,3,5,6,11 L,5,2,2,5 L,6,5,6,11 L,7,5,6,11 W,9 ")
1003:
1004: 'show noise
1005: CALL PGA.transmit("L,1,6,6,12 L,2,2,2,5 L,3,6,6,12 L,5,6,6,12 L,6,2,2,5 L,7,6,6,12 ")
1006:
1007: END SUB 'flash.screens
1008:
1009:
1010:
1011:
1012:
1013:
1014:
1015:
1016:
1017:
1018:
1019:
1020:
1021:
1022:
1023:
1024:
1025: SUB initialize.pga
1026:
1027: ' **** VARIABLE DECLARATIONS
1028: LOCAL in.string$ 'temporary string
1029:
1030:
1031: ' *** restart the PGA, enable errors, and clear the buffers
1032: CALL PGA.cold.restart
1033: DELAY 0.1
1034: CALL PGA.error.enable
1035: CALL PGA.recieve(in.string$) 'clear buffer
1036: CALL PGA.error.recieve(in.string$) 'clear buffer
1037:
1038: ' *** set communications to ASCII and reset the flags
1039: CALL PGA.transmit("CA RF WT,-320,320,-240,240 ")
1040:
1041: ' *** define LUT values (noise is set to on)
1042: CALL PGA.transmit("L,5 L,0,2,2,5 L,1,6,6,12 L,2,2,2,5 L,3,6,6,12 ")
1043: CALL PGA.transmit("L,4,2,2,5 L,5,6,6,12 L,6,2,2,5 L,7,6,6,12 L,8,6,6,12 ")
1044:

```

INITIALIZE.PGA

This module initializes the PGA to a known state, i.e., it sets the communication mode to ASCII, clears the buffers, resets the flags, defines the LUT entries, sets the mask, clears the screen, and sets the current color.

```

1045: ' *** clear the screen
1047: CALL PGA.transmit("CLS 0 ")
1048: CALL PGA.error.receive(in.string$)
1049: IF in.string$ <> "" THEN CALL print.error("PGA ERROR: "+in.string$)
1050:
1051: END SUB
1052:
1053:
1054:
1055:
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```

LOAD.NOISE.SCREEN

This module randomly selects one of the noise (masking) screens for use with one block of trials (the number of blocks having been chosen using the "Enter Stimulus Info" menu option). The number of noise screens to choose from is determined by the variable "num.noise" and must correspond to the number of noise-screen files on disk and named "XXXX#.SCR" where XXXX is the string "noise.file.name\$" and # is a number between 1 and "num.noise". The image is loaded into the PGA's memory. This process begins when "Collect Data" is chosen from the menu and takes about 6 seconds. This module also reads in the fixation point from the file fix.file.name\$.

```

SUB load.noise.screen
' **** GLOBAL DECLARATIONS
  SHARED fix.file.name$ 'file name of fixation point
  SHARED noise.file.name$ 'file name prefix of noise screen
' **** LOCAL VARIABLE DECLARATIONS
  LOCAL num% 'number of noise screen to load in
' *** determine the filename, set the mask, and load the noise screen
  num% = INT(RND*num.noise) + 1
  CALL PGA.transmit("MK,1 ")
  CALL load.screen(noise.file.name$ + CHR$(ASC("0")+num%) + ".SCR")
' *** load the fixation point
  CALL PGA.transmit("MK,8 ")
  CALL load.screen(fix.file.name$)
END SUB

```

LOAD.SCREEN

This module loads in a screen (in hex format) from the file specified by its only parameter.

```

1100:
1101:
1102:
1103:
1104:
1105:
1106: SUB load.screen(file.name$)
1107:
1108: ' **** VARIABLE DECLARATIONS
1109: LOCAL file.size& 'size of screen file in bytes
1110: LOCAL in.string$ 'temporary string
1111:
1112: ' *** open file and get size
1113: OPEN file.name$ FOR BINARY AS #2
1114: file.size& = LOF(2)
1115: IF file.size& = 0 THEN
1116: CALL pga.transmit("CA D1.1 ")
1117: CALL print.error("ERROR: "+file.name$+" not found.")
1118: CLOSE #2
1119: ERROR 255
1120: END IF
1121:
1122: ' *** load in screen and transmit to PGA
1123: SEEK #2, 0
1124:
1125: CALL PGA.error.recieve(in.string$)
1126: IF in.string$ <> "" THEN CALL print.error("PGA ERROR: "+in.string$)
1127: CALL PGA.transmit("CX ")
1128:
1129: COLOR %menu.color
1130: PRINT TAB(%entry.indent); "READING: ";
1131: WHILE NOT EOF(2)
1132: IF file.size& < %buffer.size THEN
1133: GET$ #2, file.size&, in.string$
1134: ELSE
1135: GET$ #2, %buffer.size, in.string$
1136: file.size& = file.size& + %buffer.size
1137: END IF
1138: PRINT " ";
1139: CALL PGA.transmit(in.string$)
1140: CALL PGA.error.recieve(in.string$)
1141: IF in.string$ <> "" THEN
1142: CALL print.error("PGA ERROR NUMBER: "+STR$(ASC(in.string$)))
1143: END IF
1144: WEND
1145:
1146: CALL PGA.transmit("CA ")
1147:
1148: CLOSE #2
1149:
1150: END SUB
1151:
1152:
1153:
1154:

```

'get file size

'goto beginning of file

'clear error buffer

'switch to hex mode

'if less bytes to read than buffer size

'read in the number left

'otherwise

'read in a bufferfull

'and adjust number of bytes left to be read

'send to the PGA

'check for errors

'return to ASCII mode

'close the data file


```

1155:
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1209:

```

MAKE.RANDOM.INFO

This module creates the information used by the randomize (harmonics) procedure. Specifically, the user is asked for the harmonics and their respective starting positions for each of the staircases.

```

SUB make.random.info
**** GLOBAL VARIABLE DECLARATIONS
  SHARED random.file.name$ 'file name of random harmonic info
**** LOCAL VARIABLE DECLARATIONS
  LOCAL harmonic% 'number of harmonic
  LOCAL low.start% 'starting place of lower staircase
  LOCAL num% 'number of harmonics in file
  LOCAL up.start% 'starting place of upper staircase
CLS
COLOR %menu.color
PRINT TAB(19); "FOURIER 4: MAKE RANDOM HARMONIC INFO SCREEN"
PRINT
PRINT
COLOR %option.color
OPEN random.file.name$ FOR OUTPUT AS #2
PRINT TAB(%entry.indent); : INPUT "NUMBER OF HARMONICS TO BE TESTED: ";num%
WRITE #2, num%, 1
FOR num% = 1 TO num%
  PRINT TAB(%entry.indent);
  INPUT "ENTER HARMONIC #, UPPER STAIRCASE START, LOWER STAIRCASE START: ";harmonic%, up.start%, low.start%
  WRITE #2, harmonic%, up.start%, low.start%
NEXT
CLOSE #2
END SUB

```

PLOT.SUM.FILE

This module plots the means of each harmonic versus the harmonic number. Data is read from the given sum file.

```

SUB plot.sum.file

```

```

1210:
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1264:

**** LOCAL VARIABLE DECLARATIONS
LOCAL filename$
LOCAL harmonics%()
LOCAL i
LOCAL j
LOCAL means!()
LOCAL num.harmonics%
LOCAL temps$

**** GLOBAL VARIABLE DECLARATIONS
SHARED data.file.name$

DIM harmonics%(num.harmonics)
DIM means!(num.harmonics)

' *** setup screen
CLS
COLOR %menu.color
PRINT TAB(28);"FOURIER 4: PLOT SUM FILE"
PRINT
PRINT

**** get filename and open file
PRINT TAB(%entry.indent);
INPUT "FILENAME TO PLOT (.OTS) "; filename$
OPEN data.file.name+filename$+".OTS" FOR INPUT AS #2

' *** skip header info
DO
  INPUT #2, temps$
LOOP UNTIL (VAL(temps$)<>0)

' *** read data into arrays
num.harmonics% = 0
WHILE (temps$<>"")
  INCR num.harmonics%
  IF num.harmonics% > %num.harmonics THEN
    CALL print.error("TOO MANY HARMONICS")
    EXIT SUB
  END IF
  harmonics%(num.harmonics%) = VAL(temps$)
  j = INSTR(temps$, "|")
  j = INSTR(j+1, temps$, "|")
  j = INSTR(j+1, temps$, "|")
  means!(num.harmonics%) = VAL(MID$(temps$, j+1))
  IF NOT EOF(2) THEN
    INPUT #2, temps$
  ELSE
    temps$=""
  END IF
END IF

```



```

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RANDOMIZE.TRIAL.DATA

    This module reads in the random number data file,
    randomizes the list, and writes the file back to disk. The
    file is constructed so that the first number indicates the
    number of blocks in the file. The next number represents the
    block to be used. The remaining numbers indicate the harmonic
    number and its associated starting places for its upper stair-
    case and for its lower staircase. The harmonics are read in
    sequential order and, thus, by randomizing that order, the
    order in which the harmonics are displayed is also randomized.

SUB randomize.trial.data
' **** VARIABLE DECLARATIONS
LOCAL file.pos% 'line number of next harmonic to be displayed
LOCAL file.size% 'size of file
LOCAL index% 'general indice
LOCAL index.2% 'used to swap values
LOCAL harmonics%() 'harmonic numbers
LOCAL up.case%() 'starts of upper staircases
LOCAL low.case%() 'starts of lower staircases

' **** GLOBAL VARIABLE DECLARATIONS
SHARED random.file.name$ 'filename of random number file

' *** setup screen
CLS
COLOR %menu.color
PRINT TAB(25);"FOURIER 4: RANDOMIZE TRIAL DATA"
PRINT
PRINT
'*** open the data file, read in the number of elements, read in the
'*** elements, randomize them, and write them back to disk
PRINT TAB(%entry.indent); random.file.name$; ":"; "READING.... ";
OPEN random.file.name$ FOR INPUT AS #2
INPUT #2, file.size%, file.pos%
DIM DYNAMIC harmonics%(file.size%), up.case%(file.size%), low.case%(file.size%)
FOR index% = 1 TO file.size%
    INPUT #2, harmonics%(index%), up.case%(index%), low.case%(index%)
NEXT
CLOSE #2

```

```

1375: PRINT "RANDOMIZING.... ";
1377: RANDOMIZE TIMER
1378: FOR index% = 1 to file.size%
1379:   index.2% = INT(RND*file.size%)+1
1380:   SWAP harmonics%(index%), harmonics%(index.2%)
1381:   SWAP up.case%(index%), up.case%(index.2%)
1382:   SWAP low.case%(index%), low.case%(index.2%)
1383: NEXT
1384:
1385: PRINT "WRITING... "
1386: OPEN random.file.names$ FOR OUTPUT AS #2
1387:   file.pos% = 1
1388:   WRITE #2, file.size%, file.pos%
1389:
1390:   FOR index% = 1 to file.size%
1391:     WRITE #2, harmonics%(index%), up.case%(index%), low.case%(index%)
1392:   NEXT
1393:
1394:   CLOSE #2
1395:
1396:
1397: END SUB

```

IV. LISTING OF AUXILIARY PROGRAMS

PGA.inc
PGAgraph.bas
PGAtan.asm
PGAreclv.asm
PGAerrclv.asm
mkgrdata.bas
response.inc
toolbox.inc

```

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```

```

FILENAME:          PGA.inc
PROGRAMMER:        Christopher Voltz - UDR1
CREATED:           -1/8706.18
LAST MODIFIED:     -1/8801.11
TARGET:            IBM PC w/PGA
LANGUAGE:          Turbo BASIC v1.00
REQUIRED FILES:    pgatran.bin, pgarecv.bin, pgaerrcv.bin,
                  toolbox.inc

    This file is the include module to provide
    routines to use the professional graphics adapter
    (PGA). At the beginning of the program which wishes to
    use these routines, enter the following lines:
    $INCLUDE "toolbox.inc"
    $INCLUDE "PGA.inc"

    The following services are provided:
    1) PGA.transmit ==> this routine transmits a string to
       the PGA. It is called with a string as a parameter.
       eg.: CALL PGA.transmit(in.string$) or
       eg.: CALL PGA.transmit("CA ")
    2) PGA.recieve ==> this routine reads data from the PGA
       and places it in the string parameter sent to it.
       A null string is returned if no data was available.
       eg.: CALL PGA.recieve(out.string$)
    3) PGA.error.recieve ==> this routine reads error
       messages from the PGA. A null string is returned
       if no error message was available.
       eg.: CALL PGA.error.recieve(out.string$)
    4) PGA.error.enable ==> this routine sets the flag
       which allows the PGA to send error messages.
       eg.: CALL PGA.error.enable
    5) PGA.error.disable ==> this routine resets the flag
       which allows the PGA to send error messages. When
       reset, the PGA does not send error messages.
       eg.: CALL PGA.error.disable
    6) PGA.cold.restart ==> this routine causes the PGA to
       perform a cold restart (ie. a hardware boot).
       eg.: CALL PGA.cold.restart
    7) PGA.warm.restart ==> this routine causes the PGA to
       perform a warm restart (ie. a software boot).
       eg.: CALL PGA.warm.restart
    8) PGA.print.error ==> this routine switches to the
       emulator screen, displays the error message and waits
       for the user to press a key to indicate the message
       was seen.
       eg.: CALL PGA.print.error(out.string$) or
       eg.: CALL PGA.print.error("error message")

    The following identifiers are reserved:
    %PGA.base, %PGA.error.flag, %PGA.cold.restart.flag,
    %PGA.warm.restart.flag, %PGA.set, %PGA.reset,

```

```

55: %PGA.max.string.
56:
57:
58:
59: Note that it is the user's responsibility to
60: send the correct initialization string ("CA" or "CX").
61: Also note that if data is to be sent in the hexadecimal
62: format, then the values must be placed in the string
63: using the CHR$( ) function. For further information
64: regarding use of the PGA, refer to the IBM Technical
65: Reference: Options and Adapters volume 3.
66:
67:
68:
69:
70:
71:
72:
73:
74: %PGA.base = &HC600
75: %PGA.error.flag = &H0308
76: %PGA.max.string = 1024
77: %PGA.cold.restart.flag = &H0306
78: %PGA.warm.restart.flag = &H0307
79: %PGA.set = &HFF
80: %PGA.reset = &H00
81:
82:
83:
84:
85:
86:
87:
88: SUB PGA.cold.restart
89: DEF SEG = %PGA.base
90: POKE %PGA.cold.restart.flag, PGA.set
91: DEF SEG
92: END SUB
93:
94:
95: SUB PGA.error.enable
96: DEF SEG = %PGA.base
97: POKE %PGA.error.flag, %PGA.set
98: DEF SEG
99: END SUB
100:
101:
102: SUB PGA.error.disable
103: DEF SEG = %PGA.base
104: POKE %PGA.error.flag, %PGA.reset
105: DEF SEG
106: END SUB
107:
108:
109: SUB PGA.error.recieve( out.string$ )

```

CONSTANT DEFINITIONS

```

'segment of PGA interface memory
'offset of error flag
'maximum string size returned
'offset of cold restart flag
'offset of warm restart flag
'code to set flag
'code to reset flag

```

SUBROUTINES

```

'set segment
'set cold restart flag
'return to BASIC segment

'set segment
'set error enable flag
'return to BASIC segment

'set segment
'reset error enable flag
'return to BASIC segment

```



```

110: LOCAL length%
111:
112: out.string$ = STRING$(%PGA.max.string, " ")
113: CALL PGA.error.read(length%, out.string$)
114:
115: IF (length%=0) THEN
116:   out.string$ = ""
117: ELSE
118:   out.string$ = LEFT$(out.string$, length%)
119: END IF
120: END SUB
121:
122: SUB PGA.print.error( out.string$ )
123:
124: CALL PGA.transmit("DI,1 ")
125: CALL print.error( out.string$ )
126:
127: END SUB
128:
129: SUB PGA.recieve( out.string$ )
130: LOCAL length%
131:
132: out.string$ = STRING$(%PGA.max.string, " ")
133: CALL PGA.read(length%, out.string$)
134:
135: IF (length%=0) THEN
136:   out.string$ = ""
137: ELSE
138:   out.string$ = LEFT$(out.string$, length%)
139: END IF
140: END SUB
141:
142: SUB PGA.warm.restart
143: DEF SEG = %PGA.base
144: POKE %PGA.warm.restart.flag, %PGA.set
145: DEF SEG
146: END SUB
147:
148: SUB PGA.transmit INLINE '( in.string$ )
149: $INLINE "\INCLUDE\PGAttran.bin"
150: END SUB
151:
152: SUB PGA.read INLINE '( length%, out.string$ )
153: $INLINE "\INCLUDE\PGArecv.bin"
154: END SUB

```

INLINE SUBROUTINES

```
165: END SUB
167:
168: SUB PGA.error.read INLINE '(! length%, out.string$ )
169: $INLINE "\INCLUDE\PGAerrcv.bin"
170:
171: END SUB
```

FILE=pga.inc Wed Jun 14 16:19:25 1989 PAGE=4

```

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FILENAME: pgagraph.BAS
CREATED: -1/8706.12
LAST MODIFIED: -1/8810.22
PROGRAMMER: Christopher Voltz - UDRI
TARGET: IBM PC w/PGA
LANGUAGE: Turbo BASIC

PURPOSE: This program reads in a data file consisting of
bandwidth number and 200 X, Y coordinate pairs which
represent vectors which are joined end to end. The
data is scaled to take into account the perspective of
the graphic mode used (640x350). The data is then
displayed on a standard cartesian coordinate system.
The user must specify the path name of the target file.
An extension of .DAT is assumed if none is specified.
The user can then manipulate the graph using the keys
described in the initial display page. When the user
presses the ESC key, the program terminates.

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INITIALIZATION

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**** define toolbox constants
%error.color = 12
%escape.key = 27
%false = 0
%indent = 5
%text.color = 15
%menu.color = 15
%true = -1

**** define string constants
null$ = CHR$(0)
del$ = null$ + CHR$(83)
down_arrow$ = null$ + CHR$(80)
fun.1$ = null$ + CHR$(59)
fun.2$ = null$ + CHR$(60)
fun.3$ = null$ + CHR$(61)
fun.4$ = null$ + CHR$(62)
fun.5$ = null$ + CHR$(63)
fun.6$ = null$ + CHR$(64)
fun.7$ = null$ + CHR$(65)
fun.8$ = null$ + CHR$(66)
fun.9$ = null$ + CHR$(67)
fun.10$ = null$ + CHR$(68)
fun.11$ = null$ + CHR$(84)
fun.12$ = null$ + CHR$(85)

null character string
'scan codes returned by delete key
'down arrow key 1
'function key 2
'function key 3
'function key 4
'function key 5
'function key 6
'function key 7
'function key 8
'function key 9
'function key 10
'fn1 + shift
'fn2 + shift

```

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55: fun.13$ = null$ + CHR$(86) 'fn3 + shift
57: fun.14$ = null$ + CHR$(87) 'fn4 + shift
58: fun.15$ = null$ + CHR$(88) 'fn5 + shift
59: fun.16$ = null$ + CHR$(89) 'fn6 + shift
60: fun.17$ = null$ + CHR$(90) 'fn7 + shift
61: fun.19$ = null$ + CHR$(92) 'fn9 + shift
62: fun.20$ = null$ + CHR$(93) 'fn10 + shift
63: ins$ = null$ + CHR$(82) 'insert key
64: left.arrow$ = null$ + CHR$(75) 'left arrow key
65: minus$ = CHR$(45) 'minus key
66: plus$ = CHR$(43) 'plus key
67: prt.sc$ = CHR$(42) 'print screen key
68: right.arrow$ = null$ + CHR$(77) 'right arrow key
69: up.arrow$ = null$ + CHR$(72) 'up arrow key
70: terminat$ = CHR$(27) 'escape key
71: fix.file.name$ = "screens\fixate.img" 'file name of fixation point
72:
73:
74:
75: PI = 4 * ATN(1)
76: lambda.1! = 0 'rotate image by lambda radians
77: lambda.2! = 0 'rotate fundamental by lambda radians
78: %block.size = 30000 'number of bytes in an I/O block
79:
80: aspect.ratio = 4 / 3
81: %screen.x = 320 'standard screen aspect ratio
82: %screen.y = 240 'half the horizontal size in pixels
83: pixel.mm! = 0.36 'half the vertical size in pixels
84: scale = %screen.x / %screen.y / aspect.ratio 'number of pixels per mm
85: ' scale factor for y-axis to take into account the
86: ' perspective ratio of the high resolution mode
87:
88: fill% = %false
89: x.offset% = 0 '110 'boolean: if image is filled or not
90: y.offset% = 0 'offset in x direction
91: rot% = 0 'offset in y direction
92: inc% = 10 'rotation in z direction in degrees
93: demag.inc = 0.5 'offset step size
94: demag = 13'39.5 'demagnification factor of screen
95:
96: amp.mult = 0.0 'amplitude multiplier
97: amp.step = 0.07 'amplitude step size (alpha increment)
98: amp.inc = 0 'amplitude increment step size
99: '(calculated later)
100:
101: box.size.x! = 1800 'size of digitizing box in virtual pixels
102: box.size.y! = 2150 'center of box is at (0,0) in the
103: 'virtual coordinate system
104: %radius = 15 'size of "hole" in noise screen
105: density& = 77000 'number of times to plot points on screen
106:
107: plot.size! = 2.54 / 5 'size of plot (conversion factor / #CM)
108: ' (largest size = 35 cm)
109: %plot.x = 2348 '2280 'size of plotter in X direction

```

```

110: %plot.y = 1761 '1711          'size of plotter in Y direction
112: %y.offset = 50
113:
114:      '**** define arrays to hold coefficients and coordinates
115:      DIM xx(200), yy(200), i(300), iy(300)
116:      DIM AN(61), BN(61), CN(61), DN(61), T(300)
117:
118: $include "\\include\pga.inc"
119: $include "\\include\toolbox.inc"
120:
121:
122:      '
123:      '
124:      '
125:      '
126:      '
127:      '
128:      '
129:      '
130:      '
131:      '
132:      '
133:      '
134:      '
135:      '
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146:      '
147:      '
148:      '
149:      '
150:      '
151:      '
152:      '
153:      '
154:      '
155:      '
156:      '
157:      '
158:      '
159:      '
160:      '
161:      '
162:      '
163:      '
164:      '

```

```

165: IF fill% THEN
166:   CALL PGA.transmit("C,5 ")
167:   CALL PGA.transmit("M,"+STR$(i(1))+STR$(iy(1))+")")
168:   FOR index% = 2 TO number.of.links% + 1 :200
169:     CALL PGA.transmit("D "+STR$(i(index%))+", "+STR$(iy(index%))+")")
170:   NEXT
171:   CALL PGA.transmit("C,255 M,0,0 A ")
172:   END IF
173:   CALL PGA.transmit("C,255 M,"+STR$(i(1))+STR$(iy(1))+")")
174:   FOR index% = 2 TO number.of.links% + 1 :200
175:     CALL PGA.transmit("D "+STR$(i(index%))+", "+STR$(iy(index%))+")")
176:   NEXT
177:   'draw image grabber rectangle and measuring points
178:   CALL PGA.transmit("M,"+STR$((-x.offset%)*demag)+", "+STR$((-y.offset%)*demag)+" PT ")
179:   CALL PGA.transmit("M,0,0 PT ")
180:   CALL PGA.transmit("C,5 ")
181:   CALL PGA.transmit("M,"+STR$(-box.size.xi/2)+" "+STR$(-box.size.yi/2)+" "+_
182:     "RR "+STR$(box.size.xi)+" "+STR$(box.size.yi)+" ")
183:   CALL PGA.transmit("C,255 ")
184:   'used to create fixation point
185:   CALL PGA.transmit("PF,1 M,0,"+STR$(4*demag)+" RR "+STR$(demag)+" "+_
186:     STR$(-7*demag)+" M "+STR$(-3*demag)+" 0 RR "+_
187:     STR$(7*demag)+" "+STR$(demag)+" PF,0 ")
188:   WHILE NOT INSTAT
189:     'wait until a key is pressed
190:   WEND
191:   keypressed$ = INKEY$
192:   SELECT CASE keypressed$
193:     CASE minus$
194:       INCR demag, demag.inc
195:       IF demag = 0 THEN
196:         demag = demag.inc
197:         'increase demagnification
198:       CASE plus$
199:         DECR demag, demag.inc
200:         IF demag = 0 THEN
201:           demag = -demag.inc
202:           'make sure demag is never zero
203:         'increase magnification
204:       CASE del$
205:         DECR scale, 0.01
206:         'make sure demag is never zero
207:       CASE ins$
208:         INCR scale, 0.01
209:         'decrease scale
210:       CASE left.arrow$
211:         DECR x.offset%, inc%
212:         'increase scale
213:       CASE right.arrow$
214:         INCR x.offset%, inc%
215:         'move screen left
216:       CASE up.arrow$
217:         INCR y.offset%, inc%
218:         'move screen right
219:       CASE down.arrow$
220:         DECR y.offset%, inc%
221:         'move screen up
222:       CASE prt.sc$
223:         LPRINT " AMP.MULT= "; csng(amp.mult);
224:         LPRINT " AMPLITUDE= "; amp.mult * alpha!

```

```

220: LPRINT USING " INC= #####: inc%;
221: LPRINT USING " DEMAG= #####: demag
222: LPRINT " X-OFFSET= "; INT(x.offset*pixel.mml);
223: LPRINT " Y-OFFSET= "; INT(y.offset*pixel.mml);
224: LPRINT " ROT= "; ROT*180/PI
225: LPRINT USING " BOX.SIZE.X= #####: box.size.x!
226: LPRINT USING " BOX.SIZE.Y= #####: box.size.y!
227:
228: CASE fun.1$
229: CALL PGA.transmit("DI,1 ")
230: CALL show.help.screen 'show help screen
231: CALL PGA.transmit("DI,0 ")
232: CASE fun.2$
233: DECR box.size.y!, demag 'decrease digitized Y image size in
234: CASE fun.3$
235: INCR box.size.y!, demag 'increase digitized Y image size
236: CASE fun.4$
237: CALL PGA.transmit("DI,1 ")
238: SCREEN 0
239: CLS
240: INPUT "NEW HARMONIC FREQUENCY";H
241: amp.mult = 0
242: CALL calculate.coordinates(alpha!, amp.inc, amp.mult, amp.step, -
243: pi, h, number.of.links%, t(), i(), -
244: iy(), an(), bn(), cn(), dn())
245: CALL PGA.transmit("DI,0 ")
246: 'decrease amplitude
247: CASE fun.5$
248: DECR amp.mult, amp.inc
249: CALL calculate.coordinates(alpha!, amp.inc, amp.mult, amp.step, -
250: pi, h, number.of.links%, t(), i(), -
251: iy(), an(), bn(), cn(), dn())
252: 'increase amplitude
253: CASE fun.6$
254: INCR amp.mult, amp.inc
255: CALL calculate.coordinates(alpha!, amp.inc, amp.mult, amp.step, -
256: pi, h, number.of.links%, t(), i(), -
257: iy(), an(), bn(), cn(), dn())
258: CASE fun.7$
259: CALL plot.image(i(), iy(), x.offset%, demag, y.offset%, scale)
260: CASE fun.8$
261: fill% = NOT fill%
262: CALL read.image
263: CASE fun.9$
264: CALL save.image
265: CASE fun.10$
266: CALL PGA.transmit("DI,1 ")
267: SCREEN 0
268: CLS
269: INPUT "NEW PHASE FOR FUNDAMENTAL (degrees) ";lambda.2!
270: INPUT "NEW PHASE FOR NON-FUNDAMENTAL (degrees)";lambda.1!
271: lambda.1! = (lambda.1! * PI/180)
272: lambda.2! = (lambda.2! * PI/180)
273: CALL calculate.coordinates(alpha!, amp.inc, amp.mult, amp.step, -
274: pi, h, number.of.links%, t(), i(), -
275: iy(), an(), bn(), cn(), dn())

```

```

275: CALL PGA.transmit("DI,0 ")
276: CASE fun.12$
277:   DECR box.size.x!, demag 'decrease digitized X image size in
278: CASE fun.13$
279:   INCR box.size.x!, demag 'increase digitized X image size
280: CASE fun.14$
281:   CALL read.screen
282: CASE fun.15$
283:   CALL PGA.transmit("DI,1 ")
284:   SCREEN 0
285: CLS
286: INPUT "NEW ROTATION ANGLE (degrees) ";rot!
287: rot! = (rot! * PI/180)
288: CALL calculate.coordinates(alpha!, amp.inc, amp.mult, amp.step, -
289:   pi, h, number.of.links%, t(), i(), -
290:   1y(), an(), bn(), cn(), dn())
291: CALL PGA.transmit("DI,0 ")
292: CASE fun.16$
293:   CALL make.noise.screen
294: CASE fun.17$
295:   CALL PGA.transmit("DI,1 ")
296:   SCREEN 0
297: CLS
298: INPUT "Enter new amplitude level: ";amp.mult
299: amp.mult = amp.mult / alpha!
300: CALL calculate.coordinates(alpha!, amp.inc, amp.mult, amp.step, -
301:   pi, h, number.of.links%, t(), i(), -
302:   1y(), an(), bn(), cn(), dn())
303: CALL PGA.transmit("DI,0 ")
304: CASE fun.19$
305:   CALL read.2.images
306: CASE fun.20$
307:   CALL PGA.transmit("DI,1 ")
308:   SCREEN 0
309: CLS
310: INPUT "ENTER COMMAND TO SHELL (<CR> TO GO TO DOS): ";keypressed$
311: SHELL keypressed$
312: CALL PGA.transmit("DI,0 ")
313: END SELECT
314:
315: LOOP UNTIL keypressed$ = terminate$
316:   'exit when escape pressed
317: CALL PGA.transmit("DI,1 ")
318: SCREEN 0
319: END
320:
321: error.handler:
322: CALL PGA.error.recieve(recieve$)
323: CALL PGA.recieve(recieve$)
324: CALL PGA.transmit("CA DI,1 ")
325: CALL print.error ("ERROR "+STR$(ERR)+"": "+FNget.error.message+" at "+STR$(ERADR))
326: CALL confirm(recieve$)
327: CALL PGA.transmit("DI,0 ")
328: RESUME restart
329:

```



```

330:
331:
332:
333:
334:
335:
336:
337:
338:
339: SUB calculate.coordinates(alpha!, amp.inc, amp.mult, amp.step, pi, h,
340:   number.of.links%, t(1), i(1), iy(1), an(1), En(1), -
341:   cn(1), dn(1))
342: LOCAL s%, vr, x2, y2, theta!, mag!
343: SHARED lambda.1!, lambda.2!, rot!
344:
345:   FOR S%=1 TO number.of.links% + 1 '299
346:     VR=(2*PI*S%)/T(number.of.links%) + lambda.1!
347:     X2=amp.mult * (AN(H)*COS(VR) + BN(H)*SIN(VR))
348:     Y2=amp.mult * (CN(H)*COS(VR) + DN(H)*SIN(VR))
349:     IF H<>1 THEN
350:       VR=(2*PI*S%)/T(number.of.links%) + lambda.2!
351:       X2=AN(1)*COS(VR) + BN(1)*SIN(VR) + X2
352:       Y2=CN(1)*COS(VR) + DN(1)*SIN(VR) + Y2
353:     END IF
354:     theta! = rot!+ATN(Y2/X2)-PI*(X2<0)-2*PI*(X2>0)
355:     mag! = SQR(X2^2+Y2^2)
356:     I(S%)=INT(100*mag!*COS(theta!))
357:     IY(S%)=INT(100*mag!*SIN(theta!))
358:   NEXT
359:
360:   'alpha = sqrt( (magnitude of x)^2 + (magnitude of y)^2 )
361:   'magnitude = sqrt( real.part^2 + imaginary.part^2 )
362:   alpha! = sqrt(an(h)^2 + bn(h)^2 + cn(h)^2 + dn(h)^2)
363:   amp.inc = amp.step / alpha!
364: END SUB
365:
366:
367:
368:
369: SUB get.magnitude.data(number.of.links%, t(1), an(1), bn(1), cn(1), dn(1))
370: LOCAL file.names$, index%
371:
372:   COLOR %text.color
373:   INPUT "Filename of data file: (.DAT) ", file.names$
374:
375:   OPEN file.names$+".DAT" FOR INPUT AS #1
376:   INPUT #1, number.of.links%
377:   FOR index%= 1 TO number.of.links%
378:     INPUT #1, t(index%)
379:   NEXT
380:   FOR index%= 1 TO 60
381:     INPUT #1, AN(index%), BN(index%), CN(index%), DN(index%)
382:   NEXT
383:   CLOSE #1
384: END SUB

```

MAKE.NOISE.SCREEN

This module generates a random set of coordinates and sets them (lighting them on the screen). This is done until the density of points have been plotted. Note: a small circle centered in the center of the screen is left with nothing in it. This is to provide room for the fixation point.

SUB make.noise.screen

```

LOCAL index&
LOCAL tmp.strings$
LOCAL x%
LOCAL y%

SHARED density&
SHARED terminates$

'loop control
'temporary string
'chosen x coordinate
'chosen y coordinate

'number of points to plot on screen
'code returned by <ESC>

RANDOMIZE TIMER
CALL PGA.transmit("MK 255 CLS,0 C,255 W1,"+STR$(-%screen.x)+","+STR$(%screen.x)+","+STR$(-%screen.y)+","+STR$(%screen.y)+" ")

FOR index& = 1 TO density&
    x& = INT(2*%screen.x*RND) - %screen.x
    y& = INT(2*%screen.y*RND) - %screen.y
    IF ((x&*x& + y&*y&) > (%radius*%radius)) THEN
        CALL PGA.transmit("M,"+STR$(x&)+","+STR$(y&)+"+ PT ")
        CALL PGA.error.receive(tmp.strings$)
        IF tmp.strings<>"" THEN
            CALL PGA.print.error("PGA ERROR: #="+STR$(ASC(tmp.strings$))
            CALL PGA.transmit("CX ")
        END IF
    END IF
END IF
IF (INKEY$ = terminates$) THEN EXIT FOR
NEXT

CALL PGA.transmit("D1,1 ")
SCREEN 0
CLS
INPUT "filename to save screen under? (.SCR): ";tmp.strings$
tmp.strings$ = "screens\" + tmp.strings$
SHELL "ERASE "+tmp.strings$+".SCR"
OPEN tmp.strings$+".SCR" FOR BINARY AS #1
CALL PGA.transmit("CX ")
CALL PGA.receive(tmp.strings$)
'clear buffer

```

FILE=pgagraph.bas Wed Jun 14 16:23:01 1989 PAGE=8

```

440: FOR Y% = 0 TO 2*%screen.y-1
441: CALL PGA.transmit(CHRS(&HDB)+
442: 'IR
443: 'lowline
444: 'highline
445: 'lowX1 (start)
446: 'highX1
447: 'lowX2 (end)
448: 'highX2
449: CHR$(Y% MOD 256) + -
450: CHR$(Y% \ 256) + -
451: CHR$(0 MOD 256) + -
452: CHR$(0 \ 256) + -
453: CALL PGA.recieve(tmp.strings)
454: WHILE (tmp.strings<>"")
455: PUT$ #1, tmp.strings$
456: CALL PGA.error.recieve(tmp.strings$)
457: IF tmp.strings$<>" " THEN
458: CALL print.error("PGA ERROR: #="+STR$(ASC(tmp.strings$)))
459: CALL PGA.transmit("CX ")
460: END IF
461: DELAY 0.05
462: 'give PGA time to write data
463: CALL PGA.recieve(tmp.strings$)
464: WEND
465: NEXT
466: CLOSE #1
467: CALL PGA.transmit("CA D1,0 ")
468: BEEP
469: END SUB
470:
471: SUB plot_image(i1), iy(1), x.offset%, demag, y.offset%, scale)
472: LOCAL index%
473: LOCAL x.convert!, y.convert! x.fact!, y.fact!
474: SHARED plot.size!, number.of.{inks%
475:
476: ' initialize plotter
477: OPEN "COM1:2400,0,7,2,cd,ds,cs" AS #1
478: PRINT #1, ";;EH ECM H A ";
479: DELAY 0.5
480:
481: ' calculate scaling factors
482: x.fact! = demag*(%screen.x-x.offset%)*plot.size!
483: y.fact! = scale*demag*(%screen.y-y.offset%)*plot.size!
484: x.convert! = %plot.x / (2*x.fact!)
485: y.convert! = %plot.y / (2*y.fact!)
486:
487: PRINT #1, "p1 "
488: DELAY 4.0
489:
490: PRINT #1, STR$(CINT((i1+x.fact!)*x.convert!)); " ";
491: PRINT #1, STR$(CINT((iy(1)+y.fact!)*y.convert!)+y.offset%); " D ";
492: DELAY 0.5
493: FOR index% = 2 TO number.of.links% + 1
494: PRINT #1, STR$(CINT((i(index%)+x.fact!)*x.convert!)); " ";

```

```

495: PRINT #1, STR$(CINT((iy(index%)+y.fact!)*y.convert!)*%y.offset)
497: NEXT
498: PRINT #1, "U P0 ";
499: CLOSE #1
500:
501:
502: END SUB
503:
504:
505:
506:
507:
508:
509:
510:
511:
512:
513:
514:
515:
516: SUB read_image
517:
518: ' **** VARIABLE DECLARATIONS
519: LOCAL file.size& 'file size in bytes
520: LOCAL tmp.string$ 'temporary string
521:
522: ' *** get filename
523: CALL PGA.transmit("DI,1 CLS,0 ")
524: SCREEN 0
525:
526: INPUT "Filename to read image from? (.IMG) ", tmp.string$
527:
528: ' *** open file and get size
529: tmp.string$ = "screens\" + tmp.string$
530: OPEN tmp.string$ + ".IMG" FOR BINARY AS #1
531: file.size& = LOF(1)
532: IF file.size& = 0 THEN
533: CLOSE #1
534: SHELL "ERASE "+tmp.string$+".IMG"
535: CALL print.error("ERROR: "+tmp.string$+" does not exist.")
536: EXIT SUB
537: END IF
538:
539: ' *** load in image and transmit to PGA
540: SEEK #1, 0
541:
542: CALL PGA.error.recieve(tmp.string$)
543: IF tmp.string$ <> "" THEN
544: CALL print.error("PGA ERROR: "+tmp.string$)
545: END IF
546: CALL PGA.transmit("CX ")
547:
548: WHILE NOT EOF(1)
549: GET$ #1, %block.size, tmp.string$

```

'get file size
'if file does not exist
'notify user

'goto beginning of file
'clear error buffer

'switch to nex mode

'read in a bufferfull

READ.IMAGE

This module loads in an image (in hex format) from the file specified.

```

550: CALL PGA.transmit(tmp.string$)
551: CALL PGA.error.recieve(tmp.string$)
552: IF tmp.string$ <> "" THEN
553:     CALL print.error("PGA ERROR NUMBER: "+STR$(ASC(tmp.string$)))
554:     END IF
555: WEND
556:
557: CLOSE #1
558:
559: CALL PGA.error.recieve(tmp.string$)
560: IF tmp.string$ <> "" THEN
561:     CALL print.error("PGA ERROR NUMBER: "+STR$(ASC(tmp.string$)))
562:     END IF
563:
564: CALL PGA.transmit("CA DI,0 ")
565:
566: BEEP
567: WHILE INKEY$="": WEND
568:
569:
570: END SUB
571:
572:
573:
574:
575:
576:
577:
578:
579:
580:
581:
582:
583:
584: SUB read.screen
585:
586:     ' **** VARIABLE DECLARATIONS
587:     LOCAL file.size$ 'file size in bytes
588:     LOCAL tmp.string$ 'temporary string
589:
590:     ' *** get filename
591:     CALL PGA.transmit("DI,1 CLS,0 ")
592:     SCREEN 0
593:     CLS
594:     INPUT "Filename to read screen from? (.SCR) ", tmp.string$
595:
596:     ' *** open file and get size
597:     tmp.string$ = "screens\" + tmp.string$
598:     OPEN tmp.string$ + ".SCR" FOR BINARY AS #1
599:     file.size$ = LOF(1)
600:     IF file.size$ = 0 THEN
601:         CLOSE #1
602:         SHELL "ERASE "+tmp.string$+".IMG"
603:         CALL print.error("ERROR: "+tmp.string$+" does not exist.")
604:         EXIT SUB

```

```

605: END IF
606: ' *** load in image and transmit to PGA
607: SEEK #1, 0
608: CALL PGA.error.recieve(tmp.string$)
609: IF tmp.string$ <> "" THEN
610: CALL print.error("PGA ERROR: "+tmp.string$)
611: END IF
612: CALL PGA.transmit("CX ")
613: WHILE NOT EOF(1)
614: GET$ #1, %block.size, tmp.string$
615: CALL PGA.transmit(tmp.string$)
616: CALL PGA.error.recieve(tmp.string$)
617: IF tmp.string$ <> "" THEN
618: CALL print.error("PGA ERROR: "+tmp.string$)
619: END IF
620: CALL print.error("PGA ERROR NUMBER: "+STR$(ASC(tmp.string$)))
621: END IF
622: WEND
623: CLOSE #1
624: 'close the data file
625: 'check for errors
626: CALL PGA.error.recieve(tmp.string$)
627: IF tmp.string$ <> "" THEN
628: CALL print.error("PGA ERROR NUMBER: "+STR$(ASC(tmp.string$)))
629: END IF
630: CALL PGA.transmit("CA DI,0 ")
631: BEEP
632: WHILE INKEY$="" : WEND
633: END SUB
634: 'return to ASCII mode
635: 'display until user presses a key
636:
637:
638:
639:
640:
641:
642:
643:
644:
645:
646:
647:
648:
649:
650:
651: SUB read.2.images
652: ' *** VARIABLE DECLARATIONS
653: LOCAL file.size$ 'file size in bytes
654: LOCAL tmp.string$ 'temporary string
655: ' *** GLOBAL DECLARATIONS
656: SHARED fix.file.name$ 'file name of fixation point
657:
658:
659:

```

READ.2.IMAGES

This module loads in two images (in hex format) from the files specified. In addition, the fixation point is loaded.

```

660: ' *** get filename
662: CALL PGA.transmit("DI,1 CLS,0 ")
663: SCREEN 0
664: CLS
665: INPUT "Filename to read first image from? (.IMG) ", tmp.string$
666:
667: ' *** open file and get size
668: tmp.string$ = "screens\" + tmp.string$
669: OPEN tmp.string$ + ".IMG" FOR BINARY AS #1
670: file.size$ = LOF(1)
671: IF file.size$ = 0 THEN
672:   CLOSE #1
673:   SHELL "ERASE "+tmp.string$+".IMG"
674:   CALL print.error("ERROR: "+tmp.string$+" does not exist.")
675:   EXIT SUB
676: END IF
677:
678: ' *** load in image and transmit to PGA
679: SEEK #1, 0
680: CALL PGA.error.recieve(tmp.string$)
681: IF tmp.string$ <> "" THEN
682:   CALL print.error("PGA ERROR: "+tmp.string$)
683: END IF
684: CALL PGA.transmit("CX ")
685:
686: WHILE NOT EOF(1)
687:   GET$ #1, %block.size, tmp.string$
688:   CALL PGA.transmit(tmp.string$)
689:   CALL PGA.error.recieve(tmp.string$)
690:   IF tmp.string$ <> "" THEN
691:     CALL print.error("PGA ERROR NUMBER: "+STR$(ASC(tmp.string$)))
692:   END IF
693: WEND
694:
695: CLOSE #1
696:
697: CALL PGA.error.recieve(tmp.string$)
698: IF tmp.string$ <> "" THEN
699:   CALL print.error("PGA ERROR NUMBER: "+STR$(ASC(tmp.string$)))
700: END IF
701:
702: INPUT "Filename to read second image from? (.IMG) ", tmp.string$
703:
704: ' *** open file and get size
705: tmp.string$ = "screens\" + tmp.string$
706: OPEN tmp.string$ + ".IMG" FOR BINARY AS #1
707: file.size$ = LOF(1)
708: IF file.size$ = 0 THEN
709:   CLOSE #1
710:   SHELL "ERASE "+tmp.string$+".IMG"
711:   CALL print.error("ERROR: "+tmp.string$+" does not exist.")
712:   EXIT SUB
713:
714:

```

```

715:
717:
718:
719:
720:
721:
722:
723:
724:
725:
726:
727:
728:
729:
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732:
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756:
757:
758:
759:
760:
761:
762:
763:
764:
765:
766:
767:
768:
769:

' *** load in image and transmit to PGA
SEEK #1, 0

CALL PGA.error.recieve(tmp.string$)
IF tmp.string$ <> "" THEN
  CALL print.error("PGA ERROR: "+tmp.string$)
END IF
CALL PGA.transmit("CX ")

WHILE NOT EOF(1)
  GET$ #1, %block.size, tmp.string$
  CALL PGA.transmit(tmp.string$)
  CALL PGA.error.recieve(tmp.string$)
  IF tmp.string$ <> "" THEN
    CALL print.error("PGA ERROR NUMBER: "+STR$(ASC(tmp.string$)))
  END IF
WEND

CLOSE #1

CALL PGA.error.recieve(tmp.string$)
IF tmp.string$ <> "" THEN
  CALL print.error("PGA ERROR NUMBER: "+STR$(ASC(tmp.string$)))
END IF

' *** open file and get size
PRINT "LOADING FIXATION POINT."
OPEN fix.file.name$ FOR BINARY AS #1
file.size$ = LOF(1)
IF file.size$ = 0 THEN
  CLOSE #1
  SHELL "ERASE "+fix.file.name$
  CALL print.error("ERROR: "+fix.file.name$+" does not exist.")
  EXIT SUB
END IF

' *** load in image and transmit to PGA
SEEK #1, 0

CALL PGA.error.recieve(tmp.string$)
IF tmp.string$ <> "" THEN
  CALL print.error("PGA ERROR: "+tmp.string$)
END IF
CALL PGA.transmit("CX ")

WHILE NOT EOF(1)
  GET$ #1, %block.size, tmp.string$
  CALL PGA.transmit(tmp.string$)
  CALL PGA.error.recieve(tmp.string$)
  IF tmp.string$ <> "" THEN
    CALL print.error("PGA ERROR NUMBER: "+STR$(ASC(tmp.string$)))
  END IF

```



```

770: WEND
771:
772: CLOSE #1
773:
774: 'close the data file
775:
776: CALL PGA.error.recieve(tmp.string$)
777: IF tmp.string$ <> "" THEN
778:     CALL print.error("PGA ERROR NUMBER: "+STR$(ASC(tmp.string$)))
779: END IF
780:
781: CALL PGA.transmit("CA DI,0 ")
782:
783: BEEP
784: WHILE INKEY$="" : WEND
785:
786: END SUB
787:
788:
789:
790: SUB save_image
791:     LOCAL tmp.string$, y.start%, y.end%, x.start%, x.end%
792:     SHARED box.size.x!, box.size.y!, y.offset%, x.offset%, demag, scale
793:
794:     CALL PGA.transmit("DI,1 ")
795:     SCREEN 0
796:     CLS
797:
798:     INPUT "filename to save image under? (.IMG) ", tmp.string$
799:     tmp.string$ = "screens\" + tmp.string$
800:     SHELL "ERASE "+tmp.string$+".IMG"
801:     OPEN tmp.string$+".IMG" FOR BINARY AS #1
802:     CALL PGA.transmit("CX ")
803:     CALL PGA.recieve(tmp.string$)
804:
805:     'clear buffer
806:
807:     x.start% = (-box.size.x!/2+((screen.x+x.offset%)*demag)*((2*screen.x-1)/(2*demag*screen.x))+1
808:     x.end% = (-box.size.x!/2+((screen.x+x.offset%)*demag)*((2*screen.x-1)/(2*demag*screen.x))-1
809:     y.start% = (-box.size.y!/2+((screen.y+y.offset%)*demag*scale)*((2*screen.y-1)/(2*demag*scale*screen.y))+1
810:     y.end% = (-box.size.y!/2+((screen.y+y.offset%)*demag*scale)*((2*screen.y-1)/(2*demag*scale*screen.y))-1
811:     IF (x.start%<0) OR (x.end%>screen.x*2-1) OR
812:        (y.start%<0) OR (y.end%>screen.y*2-1) THEN
813:         CALL print.error("ERROR: digitizing box is too large.")
814:     ELSE
815:         CLOSE #1
816:         CALL PGA.transmit("DI,0 ")
817:         EXIT SUB
818:     END IF
819:
820: FOR y.coord% = y.start% TO y.end%
821:     CALL PGA.transmit(CHRS(&H08)+
822:         CHR$(y.coord% MOD 256) + -
823:         CHR$(y.coord% \ 256) + -
824:         CHR$(x.start% MOD 256) + -
825:         CHR$(x.start% \ 256) + -
826:         CHR$(x.end% MOD 256) + -
827:         CHR$(x.end% \ 256) )
828:     'IR
829:     'lowline
830:     'highline
831:     'lowX1 (start)
832:     'highX1
833:     'lowX2 (end)
834:     'highX2

```

```

825: CALL PGA.recieve(tmp.string$)
827: WHILE (tmp.string$<>"")
828: PUT$ #1, tmp.string$
829: CALL PGA.error.recieve(tmp.string$)
830: IF tmp.string$<>" " THEN
831: CALL print.error("PGA ERROR: #="+STR$(ASC(tmp.string$)))
832: CALL PGA.transmit("CX ")
833: END IF
834: DELAY 0.05
835: CALL PGA.recieve(tmp.string$)
836: NEXT
837: CLOSE #1
838: BEEP
839: CALL PGA.transmit("CA DI,0 ")
840: BEEP
841: END SUB
842:
843: SUB setup.screen(x.offset%, demag, y.offset%, scale)
844: transmit$ = "WJ" + STR$((-x.screen.x-x.offset%)* demag) + " " + -
845: STR$((-x.screen.x-x.offset%)* demag) + " " + -
846: STR$((-x.screen.y-y.offset%)* demag * scale) + " " + -
847: STR$((-x.screen.y-y.offset%)* demag * scale) + " " + -
848: CALL PGA.transmit(transmit$)
849: CALL PGA.transmit("CLS,0 DI,0 ")
850: CALL PGA.transmit("TS,"+STR$(8*demag)+" ")
851: END SUB
852:
853: SUB show.help.screen
854: LOCAL responses$
855: SHARED terminates$
856: SCREEN 0
857: CLS
858: COLOR %text.color
859: PRINT TAB(11); "
860: PRINT TAB(11); "
861: PRINT TAB(11); "
862: PRINT TAB(11); "
863: PRINT TAB(11); "
864: PRINT TAB(11); "
865: PRINT TAB(11); "
866: PRINT TAB(11); "
867: PRINT TAB(11); "
868: PRINT TAB(11); "
869: PRINT TAB(11); "
870: PRINT TAB(11); "
871: PRINT TAB(11); "
872: PRINT TAB(11); "
873: PRINT TAB(11); "
874: PRINT TAB(11); "
875: PRINT TAB(11); "
876: PRINT TAB(11); "
877: PRINT TAB(11); "
878: PRINT TAB(11); "
879: PRINT TAB(11); "

```

DEFINITIONS

IMAGE: the fourier descriptor itself. A descriptor is comprised of a fundamental part (harmonic = 0) and a nonfundamental part (harmonic is as specified by user).

SCREEN: two images combined by either the mkscreen program (for FOURIER) or the display routines in FOURIER2 or FOURIER3.

```

880: PRINT TAB(11); " "
881: PRINT TAB(11); " "
882: PRINT TAB(11); " "
883: PRINT TAB(11); " "
884: PRINT TAB(11); " "
885: PRINT TAB(11); " "
886: PRINT TAB(11); " "
887: PRINT TAB(11); " "
888: PRINT TAB(11); " "
889: PRINT TAB(11); " "
890: PRINT TAB(11); " "
891: PRINT TAB(11); " "
892: PRINT TAB(11); " "
893: LOCATE 25, 1
894: COLOR 15, 1
895: PRINT STRING$(80, " ");
896: LOCATE 25, 20
897: PRINT "PGA graph v 1.10 By Christopher Voltz";
898: DELAY 1,0
899: LOCATE 25, 1
900: COLOR 28, 1
901: PRINT STRING$(80, " ");
902: LOCATE 25, 21
903: PRINT "PRESS ANY KEY TO CONTINUE, ESC to skip";
904: CALL get.key(response$)
905: IF response$ = terminates$ THEN skip
906: COLOR text.color, 0
907: CLS
908: PRINT TAB(11); " "
909: PRINT TAB(11); " "
910: PRINT TAB(11); " "
911: PRINT TAB(11); " "
912: PRINT TAB(11); " "
913: PRINT TAB(11); " "
914: PRINT TAB(11); " "
915: PRINT TAB(11); " "
916: PRINT TAB(11); " "
917: PRINT TAB(11); " "
918: PRINT TAB(11); " "
919: PRINT TAB(11); " "
920: PRINT TAB(11); " "
921: PRINT TAB(11); " "
922: PRINT TAB(11); " "
923: PRINT TAB(11); " "
924: PRINT TAB(11); " "
925: PRINT TAB(11); " "
926: PRINT TAB(11); " "
927: PRINT TAB(11); " "
928: PRINT TAB(11); " "
929: PRINT TAB(11); " "
930: PRINT TAB(11); " "
931: PRINT TAB(11); " "
932: LOCATE 25, 1
933: COLOR 28, 1
934: PRINT STRING$(80, " ");

```

FUNCTION KEY DESIGNATIONS	
- (minus)	demagnify image
+ (plus)	magnify image
INS	increase perspective factor
DEL	decrease perspective factor
PRISC	print variable values on printer
ESC	terminate program
LEFT ARROW	move image left
RIGHT ARROW	move image right

```

980: PRINT TAB(11); " "
981: PRINT TAB(11); " "
982: PRINT TAB(11); " "
983: PRINT TAB(11); " "
984: PRINT TAB(11); " "
985: PRINT TAB(11); " "
986: PRINT TAB(11); " "
987: PRINT TAB(11); " "
988: PRINT TAB(11); " "
989: PRINT TAB(11); " "
990: PRINT TAB(11); " "
991: PRINT TAB(11); " "
992: PRINT TAB(11); " "
993: PRINT TAB(11); " "
994: PRINT TAB(11); " "
995: PRINT TAB(11); " "
996: PRINT TAB(11); " "
997: PRINT TAB(11); " "
998: PRINT TAB(11); " "
999: PRINT TAB(11); " "

```

FUNCTION KEY DESIGNATIONS (continued)	
UP ARROW	move image up
DOWN ARROW	move image down
F1	display these help pages
F2	decrease digitized image size Y
F3	increase digitized image size Y
F4	select new harmonic frequency
F5	decrease amplitude of harmonic
F6	increase amplitude of harmonic
F7	plot image on HIPILOT DMP-29
F8	toggle fill on/off
F9	read digitized image
F10	save digitized image in AOI
F11 (shift +f1)	change phase shift
F12	decrease digitized image size X
F13	increase digitized image size X
F14	load in a screen (.SCR file)
F15	rotate image (geometrically)
F16	make a noise screen (.SCR)
F17	enter new amplitude level

```

935: LOCATE 25, 21
937: PRINT "PRESS ANY KEY TO CONTINUE, ESC to skip";
938: CALL get.key(response$)
939: IF response$ = terminates$ THEN skip
940: COLOR text.color, 0
941: CLS
942: PRINT TAB(11); " "
943: PRINT TAB(11); " "
944: PRINT TAB(11); " "
945: PRINT TAB(11); " "
946: PRINT TAB(11); " "
947: PRINT TAB(11); " "
948: PRINT TAB(11); " "
949: PRINT TAB(11); " "
950: PRINT TAB(11); " "
951: PRINT TAB(11); " "
952: PRINT TAB(11); " "
953: PRINT TAB(11); " "
954: PRINT TAB(11); " "
955: PRINT TAB(11); " "
956: PRINT TAB(11); " "
957: PRINT TAB(11); " "
958: PRINT TAB(11); " "
959: PRINT TAB(11); " "
960: PRINT TAB(11); " "
961: PRINT TAB(11); " "
962: PRINT TAB(11); " "
963: PRINT TAB(11); " "
964: PRINT TAB(11); " "
965: PRINT TAB(11); " "
966: LOCATE 25, 1
967: COLOR 28, 1
968: PRINT STRING$(80, " ");
969: LOCATE 25, 21
970: PRINT "PRESS ANY KEY TO CONTINUE, ESC to skip";
971: CALL get.key(response$)
972: IF response$ = terminates$ THEN skip
973: COLOR text.color, 0
974: CLS
975: PRINT TAB(11); " "
976: PRINT TAB(11); " "
977: PRINT TAB(11); " "
978: PRINT TAB(11); " "
979: PRINT TAB(11); " "
980: PRINT TAB(11); " "
981: PRINT TAB(11); " "
982: PRINT TAB(11); " "
983: PRINT TAB(11); " "
984: PRINT TAB(11); " "
985: PRINT TAB(11); " "
986: PRINT TAB(11); " "
987: PRINT TAB(11); " "
988: PRINT TAB(11); " "
989: PRINT TAB(11); " "

```

FUNCTION KEY DESIGNATIONS (continued)	
F19	read two digitized images
F20	execute DOS command
DISPLAY NOTES	
At the bottom of the graphic screen is a status line. It displays the following information respectively:	
(X,Y)	=> the X and Y position of the center of the image relative to the center of the screen (0,0). Negative X means to the left and negative Y means below. The units are mm.
DEMAG	=> the demagnification factor of the screen. Larger numbers make a smaller image.
H	=> number of harmonic being displayed.
AMP	=> amplitude of harmonic added to the fundamental.
PHI.1	=> phase angle of harmonic
PHI.2	=> phase angle of fundamental
ROT	=> angle of geometric rotation of image.

```

990: LOCATE 25, 1
991: COLOR 28, 1
992: PRINT STRING$(80, " ");
993: LOCATE 25, 21
994: PRINT "PRESS ANY KEY TO CONTINUE, ESC to skip";
995: CALL get.key(response$)
996: IF response$ = terminates$ THEN skip
997: COLOR text.color, 0
998: CLS
999: PRINT TAB(11); " "
1000: PRINT TAB(11); " "
1001: PRINT TAB(11); " "
1002: PRINT TAB(11); " "
1003: PRINT TAB(11); " "
1004: PRINT TAB(11); " "
1005: PRINT TAB(11); " "
1006: PRINT TAB(11); " "
1007: PRINT TAB(11); " "
1008: PRINT TAB(11); " "
1009: PRINT TAB(11); " "
1010: PRINT TAB(11); " "
1011: PRINT TAB(11); " "
1012: PRINT TAB(11); " "
1013: PRINT TAB(11); " "
1014: PRINT TAB(11); " "
1015: PRINT TAB(11); " "
1016: PRINT TAB(11); " "
1017: PRINT TAB(11); " "
1018: PRINT TAB(11); " "
1019: PRINT TAB(11); " "
1020: PRINT TAB(11); " "
1021: PRINT TAB(11); " "
1022: PRINT TAB(11); " "
1023: PRINT TAB(11); " "
1024: PRINT TAB(11); " "
1025: PRINT TAB(11); " "
1026: PRINT TAB(11); " "
1027: PRINT TAB(11); " "
1028: PRINT TAB(11); " "
1029: PRINT TAB(11); " "
1030: PRINT TAB(11); " "
1031: PRINT TAB(11); " "
1032: PRINT TAB(11); " "
1033: PRINT TAB(11); " "
1034: PRINT TAB(11); " "
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1036: PRINT TAB(11); " "
1037: PRINT TAB(11); " "
1038: PRINT TAB(11); " "
1039: PRINT TAB(11); " "
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1056: PRINT TAB(11); " "
1057: PRINT TAB(11); " "
1058: PRINT TAB(11); " "
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1060: PRINT TAB(11); " "
1061: PRINT TAB(11); " "
1062: PRINT TAB(11); " "
1063: PRINT TAB(11); " "
1064: PRINT TAB(11); " "
1065: PRINT TAB(11); " "
1066: PRINT TAB(11); " "
1067: PRINT TAB(11); " "
1068: PRINT TAB(11); " "
1069: PRINT TAB(11); " "
1070: PRINT TAB(11); " "
1071: PRINT TAB(11); " "
1072: PRINT TAB(11); " "
1073: PRINT TAB(11); " "
1074: PRINT TAB(11); " "
1075: PRINT TAB(11); " "
1076: PRINT TAB(11); " "
1077: PRINT TAB(11); " "
1078: PRINT TAB(11); " "
1079: PRINT TAB(11); " "
1080: PRINT TAB(11); " "
1081: PRINT TAB(11); " "
1082: PRINT TAB(11); " "
1083: PRINT TAB(11); " "
1084: PRINT TAB(11); " "
1085: PRINT TAB(11); " "
1086: PRINT TAB(11); " "
1087: PRINT TAB(11); " "
1088: PRINT TAB(11); " "
1089: PRINT TAB(11); " "

```

SPECIFIC EXPERIMENT NOTES	
DEMAG = 13	=> 40 mm (horizontally)
DEMAG = 9	=> 60 mm (horizontally)
X = -60	=> center of figure 60 mm left of screen center
X = +60	=> center of figure 60 mm right of screen center
BOX.SIZE	=> size of digitization box in relative units. The actual size of the box changes in direct relation to the

```

990: PRINT TAB(11); " " demagnification factor but its size
992: PRINT TAB(11); " " relative to the image is constant at
993: PRINT TAB(11); " " whatever size is chosen.
994: PRINT TAB(11); " " BOX.SIZE.X => 1800
995: PRINT TAB(11); " " BOX.SIZE.Y => 2150
996: PRINT TAB(11); " "
997: LOCATE 25, 1
998: COLOR 28, 1
999: PRINT STRING$(80, " ");
1000: LOCATE 25, 27
1001: PRINT "PRESS ANY KEY TO CONTINUE";
1002: CALL get.key(response$)
1003: skip:
1004: COLOR %text.color, 0
1005: CLS
1006: END SUB

```

```

1: TITLE   PGA_transmit_routine
2: PAGE    55, 132
3:
4: COMMENT *
5:
6:
7:
8:
9:
10:
11:
12:
13:
14:
15:
16:
17:
18:
19:
20:
21:
22:
23:
24:
25:
26:
27:
28:
29:
30:
31:
32:
33:
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45:
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50:
51:
52:
53:
54:

```

```

FILENAME:      PGAttran.asm
PROGRAMMER:    Christopher Voltz - UDRI
CREATED:       -1/8706.11
LAST MODIFIED: -1/8706.26
REQUIREMENTS: IBM PGA
INTERFACE PROTOCOL: Turbo BASIC

```

```

PURPOSE: This include module allows character strings
to be sent to the Professional Graphics Adapter (PGA)
from a Turbo BASIC program.

```

```

The PGA uses a fifo structure to communicate.
Two pointers are maintained, ie. the read and write
pointers. Both are indices (from 0 to 255) into the
output fifo which is located at an offset of 0000H from
the PGA segment. When the two pointers are equal, the
queue is full and no writes may take place until the
PGA has caught up. The queue is checked for room for
a byte to be added by checking to see if the write
pointer + 1 (modulo 256 because the queue is circular)
is not equal to the read pointer. If there is room,
the byte is added and the write pointer is updated;
otherwise, a loop is executed to wait until the PGA is
ready.

```

LABEL DEFINITIONS

```

PGA_base      EQU    0C600H ; segment of PGA interface memory
read_pointer  EQU    00301H ; output read pointer
write_pointer EQU    00300H ; output write pointer

```

STRUCTURE DEFINITIONS

```

stack_struct STRUCT
old_bp      DW    ? ; old base pointer
return_addr DD    ? ; far return address
string      DD    ? ; 32-bit pointer to string

```

```

55: stack_struct      ENDS
57:
58:
59:
60:
61:
62:
63:
64: program SEGMENT
65:
66:     ASSUME CS:program
67:     PUSH BP
68:     MOV BP, SP
69:
70:
71:     PUSH DS
72:     PUSH ES
73:
74:     LES SI, [BP].string
75:     MOV CX, ES:[SI]
76:     AND CH, 01111111B
77:     MOV SI, ES:[SI+2]
78:     MOV ES, DS:[0]
79:     MOV BX, PGA_base
80:     MOV DS, BX
81:     MOV DI, write_pointer
82:     SUB BH, BH
83:
84: jmp_1: MOV BL, [DI]
85:     INC BL
86:     CMP BL, DS:[read_pointer]
87:     JE SHORT jmp_1
88:     MOV AL, ES:[SI]
89:     DEC BL
90:     MOV [BX], AL
91:     INC BYTE PTR [DI]
92:     INC SI
93:     LOOP jmp_1
94:
95:     POP ES
96:     POP DS
97:
98:     POP BP
99:
100: program ENDS
101:
102:     END
103:

```

PGA TRANSMIT PROCEDURE

```

;setup stack addressing
;save segment registers
;get pointer to string descriptor
;get string length
;clear high bit
;get offset of first character
;get segment of strings
;get PGA segment
;get offset of output write pointer
;zero BH, BX will point to destination
;get pointer to end of queue
;check if room for one more byte
;by checking if (WP + 1) mod 256 is
;not equal to RP, wait if no room
;otherwise, move byte from string
;to PGA queue
;update write pointer
;point to next character
;repeat until CX=0
;restore segment registers
;restore stack

```

```

1: TITLE    PGA_recieve_routine
2: PAGE     55, 132
3:
4: COMMENT  *
5:
6:
7: FILENAME:  PGArecev.asm
8: PROGRAMMER: Christopher Voltz - UDRI
9: CREATED:   -1/8706.18
10: LAST MODIFIED: -1/8711.07
11: REQUIREMENTS: IBM PGA
12: INTERFACE PROTOCOL: Turbo BASIC
13:
14:
15: PURPOSE: This include module allows character strings
16: to be read from the Professional Graphics Adapter (PGA)
17: from a Turbo BASIC program.
18:
19: The PGA uses a fifo structure to communicate.
20: Two pointers are maintained, ie. the read and write
21: pointers. Both are indices (from 0 to 255) into the
22: input fifo which is located at an offset of 0100H from
23: the PGA segment. When the two pointers are equal, the
24: queue is empty and no reads may take place until the
25: PGA has sent data. If the queue is not empty,
26: characters are read one at a time and placed into the
27: string until there are no more characters to be read or
28: the string is full.
29:
30: This routine requires that a string be sent to
31: it which has been filled with some character (this
32: routine is not allowed to alter the string length, only
33: its contents; so if a string of length=256 is sent, a
34: maximum of 256 bytes may be read.). Also, an integer
35: variable must be passed to determine the number of bytes
36: actually returned.
37:
38:
39:
40:
41:
42:
43:
44:
45:
46:
47:
48:
49:
50:
51:
52:
53:
54:

```

LABEL DEFINITIONS

```

PGA_base EQU 0C600H ; segment of PGA interface memory
queue_base EQU 00100H ; input queue base
read_pointer EQU 00303H ; input read pointer
write_pointer EQU 00302H ; input write pointer

```



```

55: ; ;
56: ; ;
57: ; ;
58: ; ;
59: stack_struct STRUC DW ? ; old base pointer
60: old_bp DD ? ; far return address
61: return_address DD ? ; 32-bit pointer to string (1/0)
62: string DD ? ; 32-bit pointer to string length (0)
63: length DD ?
64: stack_struct ENDS
65:
66:
67:
68:
69: ; ;
70: ; ;
71: ; ;
72: program SEGMENT
73: ASSUME CS:program
74:
75: PUSH BP ;setup stack addressing
76: MOV BP, SP
77:
78:
79: PUSH DS ;save segment registers
80: PUSH ES
81:
82: SUB DX, DX ;set "number of bytes read" to zero
83: LES DI, [BP].string ;get pointer to string descriptor
84: MOV CX, ES:[DI] ;get string length
85: AND CH, 01111111B ;clear high bit
86: JCXZ SHORT jmp_2 ;if null string, return
87: MOV DI, ES:[DI+2] ;get offset of first character
88: MOV ES, DS:[DI] ;get segment of strings
89: MOV BX, PGA_base ;get PGA segment
90: MOV DS, BX
91: MOV SI, read_pointer ;get offset of input read pointer
92: MOV BH, BH ;zero BH, BX will point to source
93:
94: jmp_1:
95: MOV BL, [SI] ;get pointer to start of queue
96: CMP BL, DS:[write_pointer] ;check if there is a byte to read
97: JE SHORT jmp_2 ;if equal, no bytes to read, we are done
98: MOV AL, [BX+queue_base] ;otherwise, move byte from queue
99: MOV ES, [DI], AL ;to string
100: INC DI ;point to next character
101: INC BYTE PTR [SI] ;update read pointer
102: INC DX ;update "number of bytes read"
103: LOOP jmp_1 ;repeat until string is full
104:
105: jmp_2:
106: LDS SI, [BP].length ;get pointer to string length
107: MOV [SI], DX ;return "number of bytes read" in length
108: POP ES ;restore segment registers
109: POP DS

```

```
110:
112:      POP      BP
113:
114:      program ENDS
115:
116:      END
;restore stack
```

```

1: TITLE   PGA_error_recieve_routine
2: PAGE    55, 132
3:
4: COMMENT *
5:

```

```

6:
7: FILENAME: PGAerrcv.asm
8: PROGRAMMER: Christopher Voltz - UDRI
9: CREATED: -1/8706.18
10: LAST MODIFIED: -1/8711.07
11: REQUIREMENTS: IBM PGA
12: INTERFACE PROTOCOL: Turbo BASIC
13:
14:
15:

```

```

16:
17: PURPOSE: This include module allows error messages to be
18: read from the Professional Graphics Adapter (PGA) from
19: a Turbo BASIC program.

```

```

20:
21: The PGA uses a fifo structure to communicate.
22: Two pointers are maintained, ie. the read and write
23: pointers. Both are indices (from 0 to 255) into the
24: error fifo which is located at an offset of 0200H from
25: the PGA segment. When the two pointers are equal, the
26: queue is empty and no reads may take place until the
27: PGA has sent data. If the queue is not empty,
28: characters are read one at a time and placed into the
29: string until there are no more characters to be read or
30: the string is full.

```

```

31:
32: This routine requires that a string be sent to
33: it which has been filled with some character (this
34: routine is not allowed to alter the string length, only
35: its contents; so if a string of length=256 is sent, a
36: maximum of 256 bytes may be read.). Also, an integer
37: variable must be passed to determine the number of bytes
38: actually returned.
39:
40:

```

LABEL DEFINITIONS

```

41:
42:
43:
44:
45:
46:
47: PGA_base      EQU    0C600H    ; segment of PGA interface memory
48: queue_base    EQU    00200H    ; error queue base
49: read_pointer  EQU    00305H    ; error read pointer
50: write_pointer EQU    00304H    ; error write pointer
51:
52:
53:
54:

```

STRUCTURE DEFINITIONS

```

55: ;
56: ;
57: stack_struc STRUC DW ? ; old base pointer
58: old_BP return_address DD ? ; far return address
59: ; 32-bit pointer to string (I/O)
60: string DD ? ; 32-bit pointer to string length (O)
61: length DD ?
62: ;
63: stack_struc ENDS
64:
65:
66:
67: ;
68: ;
69: ;
70: ;
71: program SEGMENT
72: ASSUME CS:program
73:
74: PUSH BP ;setup stack addressing
75: MOV BP, SP
76:
77: PUSH DS ;save segment registers
78: PUSH ES
79:
80: SUB DX, DX ;set "number of bytes read" to zero
81: DI, [BP].string ;get pointer to string descriptor
82: LES CX, ES:[DI] ;get string length
83: AND CH, 01111111B ;clear high bit
84: JCXZ SHORT jmp_2 ;if null string, return
85: MOV DI, ES:[DI+2] ;get offset of first character
86: MOV ES, DS:[DI] ;get segment of strings
87: MOV BX, PGA_base ;get PGA segment
88: MOV DS, BX
89: MOV SI, read_pointer ;get offset of input read pointer
90: MOV BH, BH ;zero BH, BX will point to source
91:
92:
93: jmp_1: MOV BL, [SI] ;get pointer to start of queue
94: CMP BL, DS:[write_pointer] ;check if there is a byte to read
95: JE SHORT jmp_2 ;if equal, no bytes to read
96: MOV AL, [BX+queue_base] ;otherwise, move byte from queue
97: MOV ES:[DI], AL ;to string
98: INC DI ;point to next character
99: INC PTR [SI] ;update read pointer
100: INC DX ;update "number of bytes read"
101: INC DX ;repeat until string is full
102: LOOP jmp_1
103:
104: jmp_2: LDS SI, [BP].s.length ;get pointer to string length
105: MOV [SI], DX ;return "number of bytes read" in length
106: POP ES ;restore segment registers
107: POP DS
108:
109:

```

PGA ERROR RECIEVE PROCEDURE

```
110:      POP      BP      ;restore stack
112:
113:      program ENDS
114:
115:      END
```

FILE=pgaerrcv.asm Thu Jun 15 04:37:11 1989 PAGE=3

```

1: 10 CLS
2: 20 PI=3.1415927#
3: 30
4: 40 DIM DIX(300),DIY(300),VIX(300),VIY(300),E(61),A(300),T(300),DT(300)
5: 50 DIM DX(300),DY(300),XP(300),YP(300),I(300),IY(300),AN(61),AN2(300)
6: 60 DIM BN(61),BN2(300),CN(61),DN(61),CN2(300),DN2(300),AN1(300),AN3(300)
7: 70 DIM EP(300),LP(300),EX2(61),EY2(61),EVR(61),AE(61),AEY(61),ABE(61)
8: 80 DIM AQW(300),COM(300),X(201),Y(201),X2(61),Y2(61),VR(61),DXP(300)
9: 90 DIM DTP(300),DYP(300),BN1(300),BN3(300),I2(300),IY2(300),T2(300)
10: 200 CLS
11: 210 LOCATE 1,20 : PRINT "Data Input - Contour Parameters"
12: 220 LOCATE 3,1
13: 230 INPUT "Enter the number of links in the chain code....: ",K
14: 240 PRINT ""
15: 250 PRINT "Starting with the origin, enter the number then"
16: 260 PRINT "the value of the links (Links Range from 0 to 7)."

```

```

55: 650 FOR N=1 TO 60
57: 660 E(N)=(T(K)/(2*(PI^2)*N))*M
58: 670 NEXT N
59: 680 HA=61
60: 690 FOR I=1 TO K
61: 700 DTP(I)=SQR((DX(I)^2)+(DY(I)^2))
62: 710 NEXT I
63: 720 AN2(1)=0:BN2(1)=0:CN2(1)=0:DN2(1)=0 :T(1)=0
64: 730 FOR N=1 TO HA-1
65: 740 FOR I=2 TO K
66: 750 AN1(I)=COS((2*PI*N*T(I))/T(K))
67: 760 BN1(I)=SIN((2*PI*N*T(I))/T(K))
68: 770 AN3(I)=COS((2*PI*N*T(I-1))/T(K))
69: 780 BN3(I)=SIN((2*PI*N*T(I-1))/T(K))
70: 790 AN2(I)=(DTP(I)/DTP(1))*((AN1(I)-AN3(I))*AN2(I-1)
71: 800 BN2(I)=(DTP(I)/DTP(1))*((BN1(I)-BN3(I))*BN2(I-1)
72: 810 CN2(I)=(DTP(I)/DTP(1))*((AN1(I)-AN3(I))*CN2(I-1)
73: 820 DN2(I)=(DTP(I)/DTP(1))*((BN1(I)-BN3(I))*DN2(I-1)
74: 830 NEXT I
75: 840 F = T(K)/(2*(N^2)*(PI^2))
76: 850 AN(N)=F * AN2(K)
77: 860 BN(N)=F * BN2(K)
78: 870 CN(N)=F * CN2(K)
79: 880 DN(N)=F * DN2(K)
80: 890 NEXT N
81: 900 S=1 : EX2(0) = 0 : EY2(0) = 0
82: 910 FOR N=1 TO 60
83: 920 EVR(N) = (2*PI*N*S)/T(K)
84: 930 EX2(N) = AN(N)*COS(EVR(N)) + BN(N)*SIN(EVR(N)) + EX2(N-1)
85: 940 EY2(N) = CN(N)*COS(EVR(N)) + DN(N)*SIN(EVR(N)) + EY2(N-1)
86: 950 NEXT N
87: 960 FOR N=1 TO 59
88: 970 AE(N) = ABS(EX2(60)-EX2(N)) : AEY(N) = ABS(EY2(60)-EY2(N))
89: 980 IF (AE(N)>AEY(N)) THEN ABE(N) = AE(N) ELSE ABE(N) = AEY(N)
90: 990 NEXT N
91: 1000 CLS : BEEP
92: 1010 INPUT "Would you like to see the error level of each harmonic? (Type Y or n) ";ANS$
93: 1020 IF ANS$ = "Y" OR ANS$ = "y" THEN GOTO 1030 ELSE 1210
94: 1030 CLS
95: 1040 FOR N=1 TO 22
96: 1050 PRINT USING "## Actual error = ##.#### Predicted error = ##.####";N,ABE(N),E(N)
97: 1060 NEXT N
98: 1070 PRINT ""
99: 1080 INPUT "Would you like to see more? (Type Y or n)"; " ANS$
100: 1090 IF ANS$ = "Y" OR ANS$ = "y" THEN GOTO 1100 ELSE GOTO 1210
101: 1100 CLS
102: 1110 FOR N=23 TO 44
103: 1120 PRINT USING "## Actual error = ##.#### Predicted error = ##.####";N,ABE(N),E(N)
104: 1130 NEXT N
105: 1140 PRINT ""
106: 1150 INPUT "Would you like to see more? (Type Y or n)"; " ANS$
107: 1160 IF ANS$ = "Y" OR ANS$ = "y" THEN GOTO 1170 ELSE GOTO 1210
108: 1170 CLS
109: 1180 FOR N=45 TO 60

```

```

110: 1190 PRINT USING "## Actual error = ##.##### Predicted error = ##.#####";N,ABE(N),E(N)
112: 1200 NEXT N
113: 1210 EP(1)=0 : LP(1)=0
114: 1220 PRINT ""
115: 1230 INPUT "Would you like to see the magnitude of the all the harmonics? (Type y or n) ";ANS$
116: 1240 IF ANS$ = "y" OR ANS$ = "Y" THEN GOTO 1250 ELSE 1470
117: 1250 CLS
118: 1260 FOR N=1 TO 22
119: 1270 MAG = LOG(SQR(AN(N)^2 +BN(N)^2)) : MAG2=LOG(SQR(CN(N)^2+DN(N)^2))
120: 1280 PRINT USING "##.##### log(SQR(A^2 +B^2)) = ##.##### log(SQR(C^2+D^2)) = ##.#####";N,MAG,MAG2
121: 1290 NEXT N
122: 1300 PRINT ""
123: 1310 INPUT "Would you like to see more? (Type Y or n) :";ANS$
124: 1320 IF ANS$ = "y" OR ANS$ = "Y" THEN GOTO 1330 ELSE 1470
125: 1330 CLS
126: 1340 FOR N=23 TO 44
127: 1350 MAG = LOG(SQR(AN(N)^2 +BN(N)^2)) : MAG2=LOG(SQR(CN(N)^2+DN(N)^2))
128: 1360 PRINT USING "##.##### log(SQR(A^2 +B^2)) = ##.##### log(SQR(C^2+D^2)) = ##.#####";N,MAG,MAG2
129: 1370 NEXT N
130: 1380 PRINT ""
131: 1390 INPUT "Would you like to see more? (Type Y or n) :";ANS$
132: 1400 IF ANS$ = "y" OR ANS$ = "Y" THEN GOTO 1410 ELSE 1470
133: 1410 CLS
134: 1420 FOR N=45 TO 60
135: 1430 MAG = LOG(SQR(AN(N)^2 +BN(N)^2)) : MAG2=LOG(SQR(CN(N)^2+DN(N)^2))
136: 1440 PRINT USING "##.##### log(SQR(A^2 +B^2)) = ##.##### log(SQR(C^2+D^2)) = ##.#####";N,MAG,MAG2
137: 1450 NEXT N
138: 1460 ,
139: 1470 PRINT ""
140:
141: INPUT "What filename should I save the data under? (.DAT) ", filename$
142: OPEN filename$+".DAT" FOR OUTPUT AS #1
143: PRINT #1, k
144: FOR index = 1 TO K 'number of links in chain code
145: PRINT #1, I(index)
146: NEXT
147: FOR index = 1 TO 60
148: PRINT #1, AN(index), BN(index), CN(index), DN(index)
149: NEXT
150: CLOSE #1
151:

```



```

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```

```

FILENAME: response.inc
PROGRAMMER: Christopher Voltz - UDRI
CREATED: -1/8712.08
LAST MODIFIED: -1/8801.11
TARGET: IBM PC w/ I/O port
INTERFACE PROTOCOL: TURBO BASIC v. 1.10
REQUIRED FILES: none

```

```

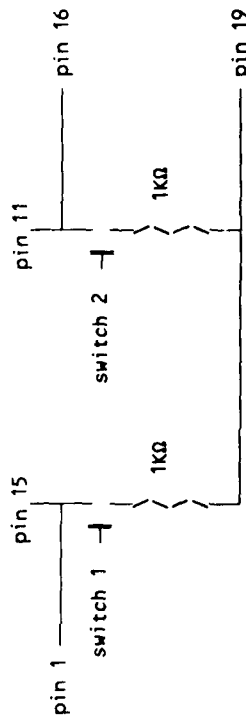
This include module allows the user to read the two
buttons connected through the response box to the parallel port
designated by the main program. The included routines are: ANDs
1) GET.RESPONSE => this routine reads data from the port, ANDs
it against the given bitmask, goes into a loop where it
continuously reads data from the port and ANDs it to the
bitmask until the new data is different from the old data
(ie. a change in states is detected), XORs the new data with
the old data to set the bits which have changed and returns
that byte of data. It is called with an integer parameter in
which to return the resulting byte of data.
eg.: CALL get.response(response%)
NOTE: if any key is pressed on the keyboard, this routine
will terminate immediately without removing the keystroke
from the keyboard buffer.
2) TEST.RESPONSE.BOX => this routine reads a response from the
response box, compares it to the two legal values the result
may have (same or different) and prints a message indicating
which button was pressed (same or different) or an error
message if the bit pattern was unrecognized.

The main program must initialize the following
variables as required:
%BIT.MASK => the bit pattern to AND the input data with; used
to clear extra bits so only relevant bits are set or reset,
eg.: %bit.mask = &B10001000 'for box which responds such
that bits 7 and 3 are set
%DIF.FERENT.BUTTON => the bit pattern which represents the
different button being pressed
eg.: %different.button = &B10000000 'if bit 7 represents
'different
%SAME.BUTTON => the bit pattern which represents the same button
being pressed,
eg.: %same.button = &B00001000 'if bit 3 represents same
%SWITCH.PORT => the address of the port to read the data from,
eg.: %switch.port = &H379 'for LPT1:

Note that due to the method used to read the data, any
type of switch and/or port combination may be used if the pins
representing the status of the buttons are constantly driven.
That is, a serial or a parallel port may be used with equal
ease if the correct data port addresses are given. Also, if

```

the button is normally open, normally closed, or momentary it will interface with these routines as they detect the change in states which must result from a button closure; however, if the button is momentary, the routines could respond with two results if the user open and closed (or vice versa) the switches slow enough that these routines were called again.
eg.: two momentary switches shall be connected to a parallel port, a sample circuit might be:



recall: pin 1 => -STROBE (provides +5V (high) for switch 1)
pin 11 => BUSY (input for switch 1 => bit 7 of status word)
pin 15 => -ERROR (input for switch => bit 3 of status word)
pin 16 => -INIT (provides +5V (high) for switch 2)
pin 19 => GROUND (provides ground (low) for switches)

If we wished to connect this to LPT1: and we wish switch 1 to represent the SAME button and switch 2 to represent the DIFFERENT button, then we would define the system parameters as shown in the previous examples for setting them.

GET.RESPONSE

This module reads the change in states from the response box connected to the %switch.port. It returns with the bits set to one which correspond to bits which have been changed.

SUB get.response(response%)

LOCAL state.1%
LOCAL state.2%

'initial state of switches
'final state of switches

```

110: state.1% = IMP(%switch.port) 'get initial state
111: state.1% = state.1% AND %bit.mask 'clear extra bits
112: DO
113: state.2% = IMP(%switch.port) 'get next state
114: state.2% = state.2% AND %bit.mask 'clear extra bits
115: LOOP UNTIL state.1% = state.2% (1, INS AT) 'wait for a change or a keypress
116: response% = state.1% XOR state.2% 'return change
117:
118:
119:
120: END SUB
121:
122:
123:
124:
125:
126:
127:
128:
129:
130:
131:
132:
133:
134: SUB test.response.box
135:
136: '**** LOCAL VARIABLE DECLARATIONS
137: LOCAL response%
138:
139: ' *** setup screen
140:
141: CLS
142: PRINT "TESTING SWITCHBOX: (connected to LPT1:)"
143: PRINT
144: PRINT "Press any keyboard key to end"
145: PRINT "Press any switchbox key to see response"
146: PRINT
147: PRINT "BEGIN:"
148:
149: COLOR %option.color
150: WHILE (INKEY$="")
151: CALL get.response(response%)
152: IF (response%=%same.button) THEN
153: PRINT " SAME"
154: ELSEIF (response%=%different.button) THEN
155: PRINT " DIFFERENT"
156: ELSE
157: COLOR %error.color
158: PRINT " ERROR: (switch pattern=";BIN$(response%);"8)"
159: COLOR %option.color
160: END IF
161: WEND
162:
163: END SUB

```

TEST.RESPONSE.BOX

This module tests the response box to make sure it is functioning correctly.

```

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```

```

FILENAME:      toolbox.inc
PROGRAMMER:    Christopher Voltz - UDRI
CREATED:       -1/8801.05
LAST MODIFIED: -1/8802.12
INTERFACE PROTOCOL: Turbo BASIC v 1.1

```

MODULE PURPOSE

This module is a collection of commonly used routines. To include these routines enter the following line in the main program's code:
`$INCLUDE "toolbox.inc"`
 By including this module you have access to the following routines:

- 1) CONFIRM ==> this routine prints an error message, waits for the user to press a key, erases the message, and returns the key pressed.
 eg.: CALL confirm(response\$)
- 2) GET.ERROR.MESSAGE\$ ==> this function returns the error message associated with the most recent error.
 eg.: error.message\$ = FN get.error.messages
- 3) GET.KEY ==> this routine reads a keypress from the keyboard and returns it.
 eg.: CALL get.key(response\$)
- 4) PARSE ==> this routine takes a string which represents a command line option and the input string without the first option. Use this routine in successive calls to parse the entire command string. White space is insignificant.
 eg.: if in.strings\$ = "/c /l"
 CALL parse(in.strings\$, out.strings\$)
 results in in.strings\$ = "/l", out.strings\$ = "c"
 5) PRINT.ERROR ==> this routine prints the given message, beeps, waits for the user to press the ESCape key, erases the message, and returns.
 eg.: CALL print.error("You idiot! You hit an invalid key.")
 6) PRINT.OPTION ==> this routine receives a string which contains two strings separated by a pipe "|". The second string is the text to be printed and the first string is the text found within the text to be printed, which is to be highlighted. This routine is case sensitive.
 eg.: CALL print.option("D|Collect Data")

The following indentifiers must be defined before these routines are called:
 %entry.indent eg.: %entry.indent = 5 'tab messages by 5

```

55: %error.color      eg.: %error.color = 4 'errors are in red
57: %menu.color      eg.: %menu.color = 7 'normal text in white
58: %menu.indent     eg.: %menu.indent = 1 'tab menus by 1
59: %option.color    eg.: %option.color = 3 'highlight in cyan
60:
61:
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63:
64:
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74:
75:
76:
77:

```

CONFIRM

This module is used to confirm that the user wishes to do something. It prints the confirm message in the error color, beeps, and waits for the user to press a key. It then erases the message, returns the cursor to its original position and returns to the calling module.

```

78: SUB confirm(out.string$)
79: ' *** VARIABLE DECLARATIONS
80: LOCAL col% 'column cursor was on when called
81: LOCAL row% 'row cursor was on when called
82: LOCAL temp$ 'temporary string variable
83:
84:
85:
86: ' *** save cursor position
87: row% = CSRLIN
88: col% = POS
89:
90: ' *** print confirm message and alert user
91: PRINT
92: PRINT TAB(%entry.indent);
93: COLOR %error.color
94: BEEP
95: PRINT "CONFIRM (Y/N): ";
96: COLOR %menu.color
97:
98: ' *** wait for user to press a key
99: DO
100:   response$ = INKEY$
101:   LOOP UNTIL response$=""
102: CALL get.key(out.string$) 'get keystroke
103:
104: ' *** clear confirm message
105: temp$ = STRING$(80*(CSRLIN-row%+1), " ")
106: LOCATE row%, col%
107: PRINT temp$;
108:
109:

```

```

110: LOCATE row%, col%
112:
113: END SUB
114:
115:
116:
117:
118:
119:
120:
121:
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123:
124:
125:
126:
127: DEF FN get.error.message$
128:
129: SELECT CASE ERR
130: CASE 2
131:   FN get.error.message$ = "Syntax error"
132: CASE 3
133:   FN get.error.message$ = "RETURN without GOSUB"
134: CASE 4
135:   FN get.error.message$ = "Out of data"
136: CASE 5
137:   FN get.error.message$ = "Illegal function call"
138: CASE 6
139:   FN get.error.message$ = "Overflow"
140: CASE 7
141:   FN get.error.message$ = "Out of memory"
142: CASE 9
143:   FN get.error.message$ = "Subscript out of range"
144: CASE 10
145:   FN get.error.message$ = "Duplicate definition"
146: CASE 11
147:   FN get.error.message$ = "Division by zero"
148: CASE 13
149:   FN get.error.message$ = "Type mismatch"
150: CASE 14
151:   FN get.error.message$ = "Out of string space"
152: CASE 15
153:   FN get.error.message$ = "String too long"
154: CASE 19
155:   FN get.error.message$ = "No RESUME"
156: CASE 20
157:   FN get.error.message$ = "RESUME without error"
158: CASE 24
159:   FN get.error.message$ = "Device time-out"
160: CASE 25
161:   FN get.error.message$ = "Device fault"
162: CASE 27
163:   FN get.error.message$ = "Out of paper"
164: CASE 50

```

GET.ERROR.MESSAGE\$

This function returns the error message associated with the most recent error.

```

165: FN get.error.message$ = "field overflow"
166: CASE 51
167: FN get.error.message$ = "Internal error"
168: CASE 52
169: FN get.error.message$ = "Bad file number"
170: CASE 53
171: FN get.error.message$ = "File not found"
172: CASE 54
173: FN get.error.message$ = "Bad file mode"
174: CASE 55
175: FN get.error.message$ = "File already open"
176: CASE 57
177: FN get.error.message$ = "Device I/O error"
178: CASE 58
179: FN get.error.message$ = "File already exists"
180: CASE 61
181: FN get.error.message$ = "Disk full"
182: CASE 62
183: FN get.error.message$ = "Input past end"
184: CASE 63
185: FN get.error.message$ = "Bad record number"
186: CASE 64
187: FN get.error.message$ = "Bad file name"
188: CASE 67
189: FN get.error.message$ = "Too many files"
190: CASE 68
191: FN get.error.message$ = "Device unavailable"
192: CASE 69
193: FN get.error.message$ = "Communications buffer overflow"
194: CASE 70
195: FN get.error.message$ = "Permission denied"
196: CASE 71
197: FN get.error.message$ = "Disk not ready"
198: CASE 72
199: FN get.error.message$ = "Disk media error"
200: CASE 74
201: FN get.error.message$ = "Rename across disks"
202: CASE 75
203: FN get.error.message$ = "Path/File access error"
204: CASE 76
205: FN get.error.message$ = "Path not found"
206: CASE 202
207: FN get.error.message$ = "Out of string temp space"
208: CASE 203
209: FN get.error.message$ = "Mismatched common variables"
210: CASE 204
211: FN get.error.message$ = "Mismatch program options"
212: CASE 205
213: FN get.error.message$ = "Mismatched program revisions"
214: CASE 206
215: FN get.error.message$ = "Invalid program file"
216: CASE 242
217: FN get.error.message$ = "String memory corrupt"
218: CASE 243
219:

```

```

220:         FN get.error.message$ = "CHAIN/RUN from .EXE file only"
222:     CASE ELSE
223:         FN get.error.message$ = ""
224:     END SELECT
225: END DEF
226:
227:
228:
229:
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```

GET.KEY

This module waits for a key to be pressed, reads it, and returns it to the calling program. The keypress is NOT echoed.

```

SUB get.key(response$)
  WHILE NOT INSTAT 'wait until a key is pressed
  WEND
  response$ = INKEY$
END SUB

```

PARSE

This module takes a string which represents options preceded by "/". It returns the first option in action\$. The rest of the string is returned in the variable it was sent in, comm\$. NOTE: the initial "/" is not returned.

```

SUB parse(comm$, action$)
  ***** VARIABLE DECLARATIONS
  LOCAL index%
  index% = INSTR(1, comm$, "/" )
  IF (index%=0) OR (comm$="") THEN
    action$ = ""
    comm$ = ""
  ELSE
    action$ = MID$(comm$, index%+1)
    index% = INSTR(1, action$, " ")
    IF (index%=0) THEN
      index% = INSTR(2, action$, "/" )
    END IF
  END IF
  'find first / (skip leading spaces)
  'if none
  'no action
  'clear commands
  'get right part of $
  'find end of command
  'if not " "
  'look for /

```



```

275: IF (index%=0) THEN
276:   comm$ = ""
277: ELSE
278:   action$ = LEFT$(action$, index%-1)
279:   comm$ = MID$(comm$, index%)
280:   END IF
281: ELSE
282:   action$ = LEFT$(action$, index%-1)
283:   comm$ = MID$(comm$, index%)
284:   END IF
285:   END IF
286:   END SUB
287:
288: PRINT.ERROR
289:
290:
291:
292:
293:
294:
295:
296:
297:
298:
299:
300:
301:
302:
303:
304: SUB print.error(in.string$)
305:
306: ' *** VARIABLE DECLARATIONS
307: LOCAL col% 'column cursor is on when called
308: LOCAL response$ 'keypress
309: LOCAL row% 'row cursor is on when called
310:
311: ' *** save cursor position
312: row% = CSRLIN
313: col% = POS
314:
315: ' *** display error message
316: PRINT
317: PRINT TAB(%entry.indent);
318: PRINT TAB(%error.color)
319: BEEP
320: PRINT in.string$
321:
322: ' *** confirm that user has seen error message
323: COLOR %menu.color
324: PRINT TAB(%entry.indent);
325: PRINT "Press <ESC> to continue";
326:
327: DO
328:
329:

```

PRINT.ERROR

This module prints an error message. The message is printed in the error color, a beep is sounded, and the user is requested to press the ESC key to continue. The message is then erased and the cursor returned to its original position.

```

330: response$ = INKEY$
331: LOOP UNTIL response$=""
332:
333: DO
334: CALL get_key(response$)
335: 'wait for user to press <ESC>
336: LOOP UNTIL ASC(response$) = %escape.key
337:
338: ' *** clear error message and return cursor to original position
339: response$ = STRING$(80*(CSRLIN-row%+1), " ")
340: LOCATE row%, col%
341: PRINT response$;
342: LOCATE row%, col%
343:
344: END SUB
345:
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360:
361: SUB print_option(in.string$)
362:
363: ' *** VARIABLE DECLARATIONS
364: LOCAL index% 'general index variable
365: LOCAL text$ 'text to highlight
366:
367: index% = INSTR(in.string$, "|")
368: text$ = LEFT$(in.string$, index%-1)
369: in.string$ = MID$(in.string$, index%+1)
370:
371:
372: index% = INSTR(in.string$, text$)
373:
374: COLOR %menu.color
375: PRINT TAB(%menu.indent); MID$(in.string$, 1, index%-1);
376:
377: COLOR %option.color
378: PRINT text$;
379:
380: COLOR %menu.color
381: PRINT MID$(in.string$, index%+LEN(text$), LEN(in.string$)-index%-LEN(text$)+1);
382:
383:
384: END SUB

```

PRINT.OPTION

This module prints a given string in the menu color and highlights the specified option key(s) using the option color. The string to be highlighted should be at the beginning of the input string and separated from the rest of the string by a pipe "|".

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